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WHITE RIVER SHALE PROJECT

DETAILED DEVELOPMENT PLAN

FEDERAL LEASE TRACTS U-a & U-b

Volume 2

Part 4: Planned Environmental Protection Procedures
Part 5: Environmental Effects of Proposed Action
Part 6: Monitoring Program
Part 7: Alternatives and Selection Rationale

Copy No. 153

FOREWORD

This document is a two-volume Detailed Development Plan (DDP) that describes a phased program for the development of the oil resources on federal oil shale lease Tracts U-a and U-b. The White River Shale Project (WRSP) has prepared this DDP for submission to the Area Oil Shale Office of the Department of the Interior to gain approval for this program.

The first section of Part 1 of this DDP explicity states the views of the White River Shale Project for the developing oil shale industry. In describing the current and anticipated problems and risks involved, outlining the actions now underway, and discussing intended future actions by WRSP, this position statement candidly defines WRSP's expectations and reservations regarding oil shale development. While many difficulties are yet to be resolved, WRSP recognizes that good progress has been made and maintains its interest in pursuing the path of commercial production of oil from shale. This DDP presents the pattern of that pursuit.

Four publications, of the 76 referenced in the DDP, are particularly relevant to this report. They are listed below:

First Year Environmental Baseline Report, White River Shale Project, VTN

White River Shale Project, Water Supply Alternatives, Bingham Engineering

Socio-Economic Impact Study of Oil Shale Development in the Uintah Basin, Western Environmental Associates

Achieving Effective Regevetation of Disposed Processed Oil Shale: A Program Emphasizing Natural Methods in an Arid Environment, Utah State University

The first of these accompanies the DDP; the other three are on file in the office of the Area Oil Shale Supervisor and are available for inspection upon request to that office.

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PART 4

Section 4.1

Section 4.1

INTRODUCTION

In Part 4, the plans and procedures proposed to reduce or mitigate the environmental impacts of the project are presented. The subsections vary in nature and include·

- More detailed descriptions of pollution control systems introduced in Part 3, including plans for air, water, and solid waste control
- Plans to rehabilitate, preserve, or manage environmental resources — for example, revegetation of disturbed lands, management of fish and wildlife, and protection of objects of historic and scientific interest
- Plans for the prevention or control of fire, accidental spills, and hazards to public health and safety

Section 4.2

Section 4.2

AIR POLLUTION CONTROL

This section describes the regulations governing air quality, identifies project-generated emission sources, and describes White River Shale Project's control plan.

4.2.1 REGULATIONS, STANDARDS, AND GUIDELINES

The only emission standards applicable to construction activities are those that control open burning (see Subsection 4.2.3.1) and those that apply to vehicular emissions. Vehicular emission standards are listed in Table 4.2-1. All vehicles used during the construction period will meet the pertinent emission standards.

During all operating stages of the project, it is intended that all plant units be operated within the limits of Federal New Source Performance Standards, summarized in Table 4.2-2.

Regulations controlling the levels of pollutants in the ambient atmosphere include federal and Utah state standards, which are identical. The pertinent ambient air quality standards are listed in Table 4.2-3.

Table 4.2-1

FEDERAL VEHICULAR EMISSION STANDARDS

Class Vehicle	Year	Hydro-carbons	Carbon Monoxide	Nitrogen Oxides	Other
Light-duty[a] gasoline-fueled trucks	1975+	2.0 gm/ veh. mi	20 gm/ veh. mi	3.1 gm/ veh. mi	–
Heavy-duty[b] gasoline-fueled trucks	1974+	16 gm/ bhp hr	40 gm/[c] bhp hr	(c)	–
Light-duty[a] diesel-fueled trucks	1975+	2.0 gm/ veh. mi	20 gm/ veh. mi	3.1 gm/ veh. mi	–
Heavy-duty[b] diesel-fueled trucks	1974+	16 gm/ bhp hr[c]	40 gm/ bhp hr	(c)	20% opacity during acceleration mode 15% opacity during lugging mode 50% peak, anytime

(a) Light duty $\leq$ 6,000 pounds GVW
(b) Heavy duty > 6,000 pounds GVW
(c) Total of hydrocarbons plus nitrogen oxides (as NO_2)

Table 4.2-2

FEDERAL NEW SOURCE PERFORMANCE STANDARDS

Type of Emission	Emission Limits		
	Fossil-Fuel-Fired Boilers	Refineries	Petroleum Storage Vessels
Particulates	Less than 0.10 lb/million Btu input	1.0 lb/1,000 lb of coke burnoff catalytic regenerator	N/A
Sulfur dioxide	Less than 0.80 lb/million million Btu liquid fuel input — less than 1.20 lb/million Btu solid fuel input	Shall not burn any fuel gas in excess of 230 mg/dscm H_2S	N/A
Nitrogen oxides	Less than: (a) 0.20 lb/million Btu heat input (0.36 g/million cal.), maximum 2-hour average, expressed as NO_2 when gaseous fossil fuel is burned (b) 0.30 lb/million Btu heat input (0.54 g/million cal.), maximum 2-hour average, expressed as NO_2 when liquid fossil fuel is burned (c) 0.70 lb/million Btu heat input (1.26 g/million cal.), maximum 2-hour average, expressed as NO_2 when solid fossil fuel (except lignite) is burned	N/A	N/A
Carbon monoxide	N/A	0.050% by volume from fluid cat cracking unit	N/A
Hydrocarbons	N/A	N/A	(1) If the true vapor pressure of the petroleum liquid, as stored, is equal to or greater than 78 mm Hg (1.5 psia) but not greater than 570 mm Hg (11.1 psia), the storage vessel shall be equipped with a floating roof, a vapor recovery system, or their equivalents (2) If the true vapor pressure of the petroleum liquid, as stored, is greater than 570 mm Hg (11.1 psia), the storage vessel shall be equipped with a vapor recovery system or its equivalent

Table 4.2-3

FEDERAL AMBIENT AIR QUALITY STANDARDS
(Same as Utah Standards)

Pollutant	Averaging Time	National Standards[a]		
		Primary[b,c]	Secondary[d]	Method of Measurement[e]
Photochemical oxidants (corrected for NO_2)	1 hour	160 $\mu g/m^3$[f] (0.08 ppm)	Same as primary standards	Chemiluminescent
Carbon monoxide	8 hours	10 mg/m^3 (9 ppm)	Same as primary standards	Nondispersive infrared spectroscopy
	1 hour	40 mg/m^3 (35 ppm)		
Nitrogen dioxide	Annual average	100 $\mu g/m^3$ (0.05 ppm)	Same as primary standards	
Sulfur dioxide	Annual average	80 $\mu g/m^3$ (0.03 ppm)	–	Pararosaniline
	24 hours	365 $\mu g/m^3$ (0.14 ppm)	–	
	3 hours	–	1,300 $\mu g/m^3$ (0.05 ppm)	
Suspended particulate matter	Annual geometric mean	75 $\mu g/m^3$	60 $\mu g/m^3$	High volume sampling
	24 hours	260 $\mu g/m^3$	150 $\mu g/m^3$	
Hydrocarbons (corrected for methane)	3 hours (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	Same as primary standards	Flame ionization detection using gas chromatography

(a) National standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year.

(b) Concentration expressed first in units which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 mm of mercury. All measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 mm of Hg (1,013.2 millibar); ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

(c) National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than 3 years after that state's implementation plan is approved by the Environmental Protection Agency (EPA).

(d) National Secondary Standards. The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after implementation plan is approved by the EPA.

(e) Reference method as described by the EPA. An "equivalent method" of measurement may be used but must have a "consistent relationship to the reference method" to be approved by the EPA.

(f) Corrected for SO_2 in addition to NO_2.

Pursuant to the Clean Air Act, the EPA has promulgated regulations to prevent "significant deterioration" of air quality in areas already cleaner than Federal Secondary Standards require. These regulations focus on particulates and sulfur oxides. Table 4.2-4 summarizes the existing EPA regulations for allowable increments of pollutants in the three proposed regional classifications.

Table 4.2-4

LIMITS OF SIGNIFICANT DETERIORATION OF AIR QUALITY

Area Designations		
Pollutant	Class I ($\mu g/m^3$)	Class II ($\mu g/m^3$)
Particulate matter:		
Annual geometeric mean	5	10
24-hour maximum	10	30
Sulfur dioxide:		
Annual arithmetic mean	2	15
24-hour maximum	5	100
3-hour maximum	25	700

Notes:

1. Class I applies to areas in which practically any change in air quality would be considered significant; Class II applies to areas in which deterioration normally accompanying moderate, well-controlled growth would be considered insignificant; and Class III applies to those areas in which deterioration up to the national standards (Table 4.2-3) would be considered insignificant (39 FR 42510).
2. Areas designated as Class I or Class II shall be limited to the above increases in pollutant concentrations over baseline air quality concentration.
3. All areas are presently designated Class II. Any redesignation shall be determined by the respective states, federal land managers, or Indian governing bodies, subject to approval by the administrator.
4. Areas designated as Class III shall be limited to concentrations of particulate matter and sulfur dioxide no greater than the national ambient air quality standards.

4.2.2 AIR POLLUTANT EMISSION INVENTORY

Tables 4.2-5 and 4.2-6 list the expected emissions from Phase II and Phase IV, respectively. Phase III is not tabulated because its emissions will be one-half of those of Phase IV. The tables also show expected stack heights, diameters, temperatures, and volume flows. Emission rates are rough estimates; as plant design progresses, emission data will be revised as appropriate.

It should be noted that many of the emission rates included in the source inventory have been estimated based on emissions from similar types of sources. This has been necessary because many of the operations included in this project are new, and source data are simply not available. It should further be noted that improved estimates of project emissions will be obtained as the project progresses through the staged development of Phases I, II, III, and IV.

A number of flare stacks have been provided to vent and burn combustible gases, if a plant upset should occur. It is expected that each of these flare stacks will be approximately 150 feet high and of smokeless design. The flare stacks and expected emissions to the atmosphere have not been included in the source inventories (Tables 4.2-5 and 4.2-6). Because the flares are standby safety devices, they will be inoperative during normal plant operations.

Table 4.2-5

AIR POLLUTANT EMISSION INVENTORY
ESTIMATED PHASE II
(Emission rates are approximate)

Activity	Material Handled	Pollutant	Emission Factor (w/o control)	Emissions (w/o control)	Control Measure and Efficiency	Emissions (w/control)	Concentration	No. of Stacks	Stack Height	Stack Diam.	Volume per Stack and Temperature
Mining	Up to 10,000 tons/ day shale	Fugitive dust	0.024 lb/hr-ton[a]	240 lb/day	Wet suppression and baffled settling chambers – 98.5%	3.6 lb/day	1.75×10^{-5} gr/SCF	–	Surface	--	1,000,000 SCFM – – ambient
Blasting	Up to 5,400 lb ANFO explosive/day (10,000 tons shale/day)	Dust	0.05 lb/ton shale	500 lb/day	Wet suppression and baffled settling chambers – 98.5%	7.5 lb/day	3.65×10^{-5} gr/SCF	–	Surface	–	1,000,000 SCFM – – ambient
		CO	0.04 lb/lb ANFO	216 lb/day	None	216.0 lb/day	1.05×10^{-3} gr/SCF				
		NO_x	0.04 lb/lb ANFO	216 lb/day	None	216.0 lb/day	1.05×10^{-3} gr/SCF				
Primary crushing	Up to 10,000 tons/ day shale	Dust	0.5 lb/ton[b]	5,000 lb/day	Wet scrubber (99% efficient)	50.0 lb/day	2.4×10^{-4} gr/SCF	–	Surface	–	Same
Mining equipment	2,000 gal/day (purchased diesel fuel)	CO	93 lb/1,000 gal[c]	186 lb/day	Catalytic converter	18.6 lb/day	9.0×10^{-5} gr/SCF	–	Surface	–	Same
		HC	30 lb/1,000 gal	60 lb/day	or wet scrubber	6.0 lb/day	2.9×10^{-5} gr/SCF	–	Surface	–	Same
		NO_x	475 lb/1,000 gal	950 lb/day	(90% efficient for	950.0 lb/day	4.6×10^{-3} gr/SCF	–	Surface	–	Same
		SO_x	0.7 lb/1,000 gal	1.4 lb/day	CO, HC)	1.4 lb/day	6.8×10^{-6} gr/SCF	–	Surface	–	Same
		Partic.	24 lb/1,000 gal	48 lb/day		48.0 lb/day	2.3×10^{-4} gr/SCF	–	Surface	–	Same
Transfer	Up to 10,000 tons/ day shale	Dust	0.05 lb/ton[d]	500 lb/day	Wet scrubber (99% efficient)	5.0 lb/day	2.43×10^{-3} gr/SCF	2	50 ft	1.46 ft	5,000 SCFM ea – ambient
Storage	75,000 tons	Dust	10 tons/acre-yr[b]	55 lb/day	None	55.0 lb/day	Unknown	–	Surface	–	–
Secondary crushing and screening	Up to 10,000 tons/ day shale	Dust	1.5 lb/ton[b]	15,000 lb/day	Wet scrubber (99% efficient)	150.0 lb/day	0.037 gr/SCF	2	50 ft	1.93 ft	10,000 SCFM ea – ambient
Vertical-type retort	Up to 10,000 tons/ day shale	Dust	0.1 lb/ton[d]	1,000 lb/day	Wet scrubber (99% efficient)	10.0 lb/day	0.0049 gr/SCF	1	50 ft	1.93 ft	10,000 SCFM ea – ambient
Processed shale moisturizer	7,000 tons/day shale	Dust	0.1 lb/ton[d]	700 lb/day	Moisturizer (99% efficient)	7.0 lb/day	0.0034 gr/SCF	1	50 ft	1.93 ft	10,000 SCFM ea – ambient
Boiler/incenerator	52.3 million SCF/ day low-Btu gas (200×10^6 Btu/hr)	Partic.	0.018 lb/10^6 Btu[e]	86 lb/day	Treated and cleaned gas	86.0 lb/day	0.0058 gr/SCF	1	100 ft	4.50 ft	72,000 SCFM ea – 350°F
		SO_2	0.04 lb/10^6 Btu	200 lb/day		200.0 lb/day	0.014 gr/SCF				
		CO	0.017 lb/10^6 Btu	80 lb/day		80.0 lb/day	0.0054 gr/SCF				
		HC	0.003 lb/10^6 Btu	14 lb/day		14.0 lb/day	0.001 gr/SCF				
		NO_x	0.20 lb/10^6 Btu	960 lb/day		960.0 lb/day	0.065 gr/SCF				
Processed shale disposal											
• Conveyor	7,000 tons/day	Dust	0.1 lb/ton[e]	700 lb/day	Wet supression	175.0 lb/day	–	–	Surface	–	–
• Truck traffic	200 miles/day	Dust	3.7 lb/mile	740 lb/day	(75% efficient)	185.0 lb/day	–	–	Surface	–	–
• Wind erosion	60 acres	Dust	10 tons/acre-yr	3,300 lb/day		825.0 lb/day	–	–	Surface	–	–
• Diesel fuel	1,000 gal/day	CO	93 lb/1,000 gal	93 lb/day	Wet scrubber or	9.3 lb/day	–	–	Surface	–	–
		HC	30 lb/1,000 gal	30 lb/day	catalytic converter	3.0 lb/day	–	–	Surface	–	–
		NO_x	475 lb/1,000 gal	475 lb/day	(90% for CO, HC)	475.0 lb/day	–	–	Surface	–	–
		SO_2	0.7 lb/1,000 gal	0.7 lb/day		0.7 lb/day	–	–	Surface	–	–
		Partic.	24 lb/1,000 gal	24 lb/day		24.0 lb/day	–	–	Surface	–	–

(a) Ref. 42
(b) Ref. 43
(c) Ref. 44
(d) Estimated
(e) Ref. 45

Table 4.2-6

AIR POLLUTANT EMISSION INVENTORY
ESTIMATED PHASE IV
(Emission rates are approximate)

Activity	Material Handled	Pollutant	Emission Factor (w/o control)	Emissions (w/o control)	Control Measure and Efficiency	Total Emissions (w/ control)	Concentration	No. of Stacks	Stack Height	Stack Diam.	Volume per Stack and Temperature
Mining	160,800 tons/day (shale)	Fugitive dust	0.024 lb/ton[a]	3,860 lb/day	Wet suppression and baffled settling chambers – 98.5%	57.9 lb/day	2.35×10^{-5} gr/SCF	–	Surface	–	12,000,000 SCFM – ambient
Blasting	80,000 lb ANFO explosive/day (160,800 tons shale/day)	Dust	0.05 lb/ton shale	8,040 lb/day	Wet suppression baffled settling chambers – 98.5%	121 lb/day	4.89×10^{-5} gr/SCF				12,000,000 SCFM – ambient
		CO	0.04 lb/lb ANFO	3,200 lb/day	None	3,200 lb/day	1.30×10^{-3} gr/SCF				
		NO_x	0.04 lb/lb ANFO	3,200 lb/day	None	3,200 lb/day	1.30×10^{-3} gr/SCF				
Primary crushing	160,800 tons/day (shale)	Dust	0.5 lb/ton[b]	80,400 lb/day	Wet scrubber (99% efficient)	804 lb/day	3.25×10^{-4} gr/SCF	–	Surface	–	Same
Mining equipment	26,000 gal/day (diesel fuel)	CO	93 lb/1,000 gal[c]	2,418 lb/day	Catalytic converter or wet scrubber (90% efficient for CO, HC)	242 lb/day	9.8×10^{-5} gr/SCF	–	Surface	–	Same
		HC	30 lb/1,000 gal	780 lb/day		78 lb/day	3.16×10^{-5} gr/SCF	–	Surface	–	Same
		NO_x	475 lb/1,000 gal	12,350 lb/day		12,350 lb/day	5.0×10^{-3} gr/SCF	–	Surface	–	Same
		SO_x	0.70 lb/1,000 gal	18.2 lb/day		18.2 lb/day	7.4×10^{-6} gr/SCF	–	Surface	–	Same
		Partic.	24 lb/1,000 gal	624 lb/day		624 lb/day	2.6×10^{-4} gr/SCF	–	Surface	–	Same
Transfer	160,800 tons/day (shale)	Dust	0.05 lb/ton[d]	8,040 lb/day	Wet scrubbers (99% efficient)	80.4 lb/day	0.020 gr/SCF	2	50 ft	1.93 ft	10,000 SCFM ea – ambient
Storage	1,000,000 tons (2 acres)	Dust	10 tons/ acre-year[b]	110 lb/day	None	110 lb/day	–	–	Surface	–	
Secondary crushing and screening	160,800 tons/day (shale)	Dust	1.5 lb/ton[b]	241,200 lb/day	Cyclone and wet scrubber (99.8% efficient)	482 lb/day	0.023 gr/SCF	10	50 ft	1.8 ft	10,000 SCFM – ambient
Vertical-type retorts (20)											
• Raw shale feed	136,000 tons/day	Dust	0.1 lb/ton[d]	13,600 lb/day	Wet scrubber (99% efficient)	136 lb/day	3.3×10^{-3} gr/SCF	20	50 ft	2.36 ft	10,000 SCFM ea – 110°F
• Shale moisturizer dust control	110,000 tons/day	Dust	0.1 lb/ton[d]	11,000 lb/day	Moisturizer (99% efficient)	110 lb/day	6.7×10^{-2} gr/SCF	4	50 ft	1.1 ft	2,000 SCFM ea – 150°F
Vertical retorts (3) (indirect heated)	400 million Btu/hr (treated low-Btu gas)	Partic.	0.018 lb/10^6 Btu	173 lb/day	Previously cleaned and treated fuel	173 lb/day	5.61×10^{-3} gr/SCF	3	150 ft	6.2 ft	150,000 SCFM 450°F
		SO_2	0.04 lb/10^6 Btu	384 lb/day		384 lb/day	1.24×10^{-2} gr/SCF				
		CO	0.017 lb/10^6 Btu	163 lb/day		163 lb/day	5.28×10^{-3} gr/SCF				
		HC	0.003 lb/10^6 Btu	29 lb/day		29 lb/day	9.40×10^{-4} gr/SCF				
		NO_x	0.20 lb/10^6 Btu	1,920 lb/day		1,920 lb/day	6.22×10^{-2} gr/SCF				

(a) Ref. 42
(b) Ref. 43
(c) Ref. 44
(d) Assumed

Activity	Material Handled	Pollutant	Emission Factor (w/o control)	Emissions (w/o control)	Control Measure and Efficiency	Total Emissions (w/ control)	Concentration	No. of Stacks	Stack Height	Stack Diam.	Volume per Stack and Temperature
Fines-type retorts											
• Raw shale feed	24,000 tons/day (shale)	Dust	0.2 lb/ton[a]	4,800 lb/day	Wet scrubber (99% efficient)	48 lb/day	0.008 gr/SCF	3	50 ft	1.8 ft	10,000 SCFM ea – ambient
• Processed shale discharge	19,000 tons/day	Dust	0.2 lb/ton[a]	3,800 lb/day	Wet scrubber (99% efficient)	38 lb/day	0.031 gr/SCF	3	50 ft	1.0 ft	2,000 SCFM ea – ambient
• Ball elutriators[b]	130 million Btu/hr equivalent from boiler flue gas	Partic.	10,000 ppm(w)[a]	60,000 lb/day	Cyclone and wet scrubber (99.75%)	150 lb/day	8.44×10^{-2}	3	200 ft	4.65 ft	37,500 SCFM ea 130°F
		SO_2	0.04 lb/10^6 Btu[c]	125 lb/day	(90%)	12.5 lb/day	3.35×10^{-3}				
		CO	0.017 lb/10^6 Btu	53 lb/day	(0%)	53 lb/day	2.48×10^{-2}				
		HC	0.003 lb/10^6 Btu	10 lb/day	(0%)	10 lb/day	1.73×10^{-2}				
		NO_x	0.20 lb/10^6 Btu	625 lb/day	(0%)	625 lb/day	2.52×10^{-1}				
• Shale pre-heaters[b]	24,000 tons/day (shale)	Partic.	1.5% of feed	720,000 lb/day	Cyclone and scrubber (99.75% effic.)	1,800 lb/day	(Included in ball elutriator emissions)	*			
	760×10^6 Btu/hr fuel oil (130,000 gal/day)	Partic.	10 lb/10^3 gal[c]	1,300 lb/day		3.25 lb/day					
		SO_2	5 lb/10^3 gal	650 lb/day	(90%)	65 lb/day					
		CO	4 lb/10^3 gal	520 lb/day	(0%)	520 lb/day					
		HC	3 lb/10^3 gal	390 lb/day	(0%)	390 lb/day					
		NO_x	40 lb/10^3 gal	5,200 lb/day	(0%)	5,200 lb/day					
Hydrogen plant	252,000 gal/day (fuel oil)	Partic.	10 lb/10^3 gal[c]	2,520 lb/day	Previously treated fuel	2,520 lb/day	0.020 gr/SCF	2	50 ft	13.7 ft	300,000 SCFM ea 500°F
		SO_2	5 lb/10^3 gal	1,260 lb/day		1,260 lb/day	0.010 gr/SCF				
		CO	4 lb/10^3 gal	1,000 lb/day		1,000 lb/day	0.008 gr/SCF				
		HC	3 lb/10^3 gal	750 lb/day		750 lb/day	0.006 gr/SCF				
		NO_x	40 lb/10^3 gal	10,080 lb/day		10,080 lb/day	0.082 gr/SCF				
Sulfur plant Tail gas treatment and Claus plant	26×10^6 SCF/day (165 tons/day)	SO_2	–	–	Treated to 300 ppmv	1,320 lb/day	0.356 gr/SCF	2	150 ft	1.94 ft	9,000 SCFM ea 180°F
Crude oil hydrotreater	398×10^6 Btu/hr (treated low-Btu gas)	Partic.	0.018 lb/10^6 Btu[c]	172 lb/day	Previously treated and cleaned gas	712 lb/day	5.81×10^{-3}	2	50 ft	6.55 ft	72,000 SCFM ea 450°F[d]
		SO_2	0.04 lb/10^6 Btu	382 lb/day		382 lb/day	1.29×10^{-2}				
		CO	0.017 lb/10^6 Btu	162 lb/day		162 lb/day	5.47×10^{-3}				
		HC	0.003 lb/10^6 Btu	29 lb/day		29 lb/day	9.79×10^{-4}				
		NO_x	0.20 lb/10^6 Btu	1,910 lb/day		1,910 lb/day	6.45×10^{-2}				

(a) Assumed
(b) Ball elutriators and shale preheaters emitted through combined flues
(c) Ref. 44
(d) Air preheaters included

Activity	Material Handled	Pollutant	Emission Factor (w/o control)	Emissions (w/o control)	Control Measure and Efficiency	Total Emissions (w/ control)	Concentrations	No. of Stacks	Stack Height	Stack Diam.	Volume per Stack and Temperature
Naphtha hydrotreater	57 x 10^6 Btu/hr (treated low-Btu gas)	Partic. SO_2 CO HC NO_x	0.018 lb/10^6 Btu[a] 0.04 lb/10^6 Btu 0.017 lb/10^6 Btu 0.003 lb/10^6 Btu 0.20 lb/10^6 Btu	25 lb/day 55 lb/day 23 lb/day 4 lb/day 275 lb/day	Previously treated and cleaned gas	25 lb/day 55 lb/day 23 lb/day 4 lb/day 275 lb/day	0.006 gr/SCF 0.012 gr/SCF 0.005 gr/SCF 0.001 gr/SCF 0.062 gr/SCF	1	50 ft	3.57 ft	21,450 SCFM 450°F[b]
Boiler power plant • Low-Btu gas	2,555 x 10^6 Btu/hr (treated low-Btu gas)	Partic. SO_2 CO HC NO_x	0.018 lb/10^6 Btu[a] 0.04 lb/10^6 Btu 0.017 lb/10^6 Btu 0.003 lb/10^6 Btu 0.20 lb/10^6 Btu	1,104 lb/day 2,453 lb/day 1,042 lb/day 184 lb/day 12,250 lb/day	Previously treated and cleaned fuel	1,104 lb/day 2,453 lb/day 1,042 lb/day 184 lb/day 12,250 lb/day	0.017 gr/SCF 0.017 gr/SCF 0.010 gr/SCF 0.004 gr/SCF 0.105 gr/SCF	1	250 ft	23 ft	1,030,000 SCFM 350°F
• Fuel oil	1,509 x 10^6 Btu/hr (250,000 gal/day) (treated fuel oil)	Partic. SO_2 CO HC NO_x	10 lb/10^3 gal[a] 5 lb/10^3 gal 4 lb/10^3 gal 3 lb/10^3 gal 40 lb/10^3 gal	2,500 lb/day 1,250 lb/day 1,000 lb/day 750 lb/day 10,000 lb/day	Previously treated fuel	2,500 lb/day 1,250 lb/day 1,000 lb/day 750 lb/day 10,000 lb/day	(Above includes both fuels)				
Ammonia recovery plant	412 tons/day	NH_3	1 lb/ton[c]	412 lb/day	Vapor recovery (99% efficient)	4 lb/day	Negligible	—	Surface	—	Ambient
Upgrading plant General emissions	100,000 BBL/day (shale oil)	Light HC	5 lb/10^3 BBL[a]	500 lb/day	—	500 lb/day	Unknown	—	Surface	—	Ambient
Processed shale disposal • Transfer	130,000 tons/day	Dust	0.05 lb/ton[d]	13,000 lb/day	Bag filter and wet suppression	650 lb/day	Unknown	2	50 ft	1.8 ft	10,000 SCFM ea — ambient
• Traffic dust	7,500 miles/day	Dust	3.7 lb/mile	27,500 lb/day	Wet suppression (75% efficient)	6,950 lb/day	Unknown	—	Surface	—	Ambient
• Wind erosion	200 acres average	Dust	10 tons/acre-yr	11,000 lb/day	Wet suppression and chemical stabilization (80% efficient)	2,200 lb/day	Unknown	—	Surface	—	Ambient
Disposal traffic	15,000 gal/day	Partic. CO HC NO_x SO_x	24 lb/10^3 gal 93 lb/10^3 gal 30 lb/10^3 gal 475 lb/10^3 gal 0.7 lb/10^3 gal	360 lb/day 1,400 lb/day 450 lb/day 7,150 lb/day 11 lb/day	Catalytic converter or wet scrubber (90 % efficient for CO, HC)	360 lb/day 140 lb/day 45 lb/day 7,150 lb/day 11 lb/day	Unknown	—	Surface	—	Ambient

(a) Ref. 44
(b) Air preheaters included
(c) Assumed
(d) Ref. 45

4.2.3 AIR POLLUTION CONTROL PLAN

4.2.3.1 Construction Phase

Construction of all phases of the project will generate dust. Plans for controlling dust and for complying with burning regulations are described in the following paragraphs.

Dust Control. The primary pollutant will be fugitive dust from traffic, blasting, grading, and other construction-related activities. To control and minimize air pollution, the following procedures will be established and practiced during construction activities on the site.

- All parking lots will be paved, oiled, or graveled. All private vehicles will be restricted to authorized parking areas only, and private vehicular traffic at the construction site will be limited.
- All construction site roadways will be paved, oiled, graveled, or wetted, as required; construction traffic will be restricted, whenever possible, to these maintained roadways. Maintenance crews will keep construction area roadways as free as possible of wheel mud and load spills.
- All areas to be graded will be kept wet by water sprays. Other areas where earth moving occurs will also be wetted during these operations.

Burning Control. At no time during plant construction or operation will open burning be conducted without a permit. All wastes will be transported to the processed shale disposal area for landfilling.

4.2.3.2 Air Pollution Control – All Operation Phases

As the WRSP development progresses from Phase II to Phase IV, increasing amounts of air pollutants will be generated. The following paragraphs describe the air pollution control plans for various stages of the project.

Mining. The drilling, blasting, scaling, loading, transferring, and unloading operations essential to mining activities will generate a substantial amount of atmospheric pollutants. A large quantity of particulates (dusts) will be generated from all basic operations, and gaseous pollutants will also be generated from blasting and operation of diesel engines. Effective control measures will be required to minimize the amount of pollutants emitted to the atmosphere. The emission sources, emission rates, control measures, and final emission rates are summarized in Tables 4.2-5 and 4.2-6.

To minimize dust from mining activities, the following control measures will be implemented and maintained:

- During drilling, water and wetting agents will be applied at the drill bit.
- The muck pile of blasted shale may be wetted before and during rock loading. Wetting agents may be employed if they prove effective in reducing water requirements or in improving dust control.
- Truck haulage roads will be maintained using conventional road wetting and chemical stabilization techniques.
- Wet suppression techniques will also be used, if necessary, while scaling sides and roof of the working area.

The gaseous air pollutants of primary concern are carbon monoxide, nitrogen oxides, and hydrocarbons resulting from diesel engines and blasting. Diesel engine combustion products will pass through a catalytic converter or a wet scrubber before entering the mine atmosphere. Proper maintenance of the engines and converters or scrubbers is the most positive means of limiting these emissions. If diesel fuel used for underground equipment is produced from the shale oil, it should be a cleaner burning fuel (in terms of smoke and sulfur dioxide) than industry standard No. 2 diesel fuel. All diesel engines will be equipped to meet federal air emission standards for underground operation.

The mine ventilation system will be designed to remove the blast fumes and dust from working panels. Before ventilation air is exhausted from the mines, it may have to be passed through mined-out panels that will act as settling chambers to reduce dust concentrations. Large openings and low ventilating current velocities will prevent the transportation of dust over long distances in the return air courses and will allow it to settle out. If this proves insufficient, additional water sprays may be installed near the bottom of the upcast shafts..

Blasting fumes will be controlled by using the proper explosives for the conditions encountered. The dust and fumes created will be diluted and removed from the working panels by an adequate amount of fresh air (up to 12,000,000 cubic feet per minute) through the mine ventilation system. Methane, if encountered, will also be diluted with these large volumes of ventilation air and exhausted.

Feed Preparation. Primary crushing will be conducted within the mine. The primary crushing units will be equipped with water sprays at the inlet hoppers to minimize fugitive dust. In addition, negative air pressure will be maintained on the inlet side of the crushers through a high-efficiency (99 percent or greater) wet scrubber. Cleaned exhaust air from the crusher and scrubber will be vented through the mine ventilation system described above. Dust emission rates from the feed preparation, control measures, and the final emission rates are summarized in Tables 4.2-5 and 4.2-6.

The secondary crushing units and the screening units will be located above ground. Each crusher and screening unit will be equipped with a wet scrubber that will have negative pressure at the inlet. Air will be drawn through the crushing and screening units and processed through the wet scrubber (99 percent or greater efficiency). Cleaned air will be exhausted directly to the atmosphere through 50-foot stacks.

Transportation and Stockpiling. Raw shale will be transported between the mine portal and the processing area by enclosed conveyor belts. To minimize fugitive dust from the movement of shale, all conveyor systems above ground will be fully enclosed, and wet scrubbers will be used at all conveyor exit points. The stacker at the raw shale stockpile will also be equipped with water sprays to minimize fugitive dust. The stockpiled raw shale will be in up to 10-inch-sized pieces as received from the primary crusher, and there should be minimal wind erosion of the stockpile and little fugitive dust from the quiescent pile.

Retorting. In Phase II, a single vertical-type retort will process up to 10,000 tons per day of raw shale. The raw shale will be transported to the retort by enclosed conveyor to minimize fugitive dust. The feed hopper and processed shale discharge bin will be equipped with a shared single wet scrubber to control particulate emissions. A star valve with positive-pressure flue gases to provide an air lock will be used to inject raw shale and remove processed shale from the retort. Under normal conditions, no other emissions will result from the vertical-type retort.

In Phases III and IV, the raw shale will be transported by a conveyor system from the secondary crushers to the vertical-type and fines-type retorts. A total of 80,000 and 160,000 tons per day, respectively, will be delivered to the retorts by this conveyor system. All conveyors will be enclosed to minimize fugitive dust. Vent gas from the processed shale moisturizer containing steam, dust, and air will be scrubbed. In addition, the three indirect-heated retorts will be provided with clean fuel (treated low-Btu gas) that will result in minimal stack emissions to the atmosphere.

The storage silo and surge bin of fine shale will be provided with a wet scrubber of 99 percent or greater efficiency. Exhaust gases from the ball elutriators and the shale preheater will be cleaned in the wet

scrubbers of 99 percent or greater efficiency and released to the atmosphere through individual stacks (one for each fines-type unit). Vent gas from the processed shale moisturizers will also be scrubbed.

Emissions from the retorting processes are described in detail in Section 4.2.2.

Shale Oil Upgrading. Shale oil will not be upgraded during Phase II. During Phases III and IV, the shale oil will be upgraded by hydrotreating. The upgrading process will consist of severe hydrotreating of the crude shale oil and will require two crude oil hydrotreater units, a naphtha hydrotreater unit, two hydrogen plants, and two sulfur plants. Each process will be essentially self-contained so that no product is released to the atmosphere. The major source of pollutants will be from the heaters used in each process.

For fuel, the two hydrogen plants will use treated high-Btu gas that will produce minimal quantities of pollutants. All flue gases will be vented to the atmosphere through two stacks (see Table 4.2-6).

The two sulfur plants will recover sulfur from the crude shale oil as it is upgraded in the hydrotreating units. Off gases from the sulfur plants will be further treated by the tail gas treatment unit. Emissions to the atmosphere will be minimal; no additional controls will be necessary.

The crude oil hydrotreater unit will use treated low-Btu fuel, and emissions to the atmosphere will be minimal. No additional control devices will be required.

The naphtha hydrotreater will also use treated low-Btu fuel, and emissions will be minimal. No additional controls will be required.

Boiler Plant. During Phase II, electrical power will be purchased. Process heat and steam will be produced in a small boiler, and excess gas (treated) will be incinerated. Emission levels will be very low because of the cleaned gas, and no additional controls will be required.

Generation of steam for processing and for electrical power production during Phases III and IV will involve the combustion of gas, oil, or combinations thereof. During Phase IV operation, the utility boilers may consume up to 670 million cubic feet of low-Btu gas and 380,000 gallons of fuel oil daily. The gas and oil will both be treated, and their sulfur contents will be less than 0.004 percent and 0.025 percent, respectively. Emissions to the atmosphere will be within pertinent federal new-source performance standards, and no pollution controls will be required for the boilers. Exhaust gases from the boilers will be emitted to the atmosphere through a single stack.

Processed Shale Disposal. The processed shale will be transported to a disposal site in Southam Canyon. The shale will move from the retorting area by enclosed conveyor to a loadout bin where wet suppression by water sprays will reduce fugitive dust both at the conveyor discharge and at the bin discharge. Trucks will transport the processed shale from the loadout bin to the disposal area. The shale will be moist, and little or no fugitive dust will occur from transportation. At the disposal area, the shale will again be wetted by water spray; surfactants will be used as necessary to achieve maximum wetting and dust suppression. Grading of the disposed shale will be conducted with the shale in a moistened condition, and little dust should be generated during this process. Haul roads will be wetted to minimize fugitive dust from truck traffic.

4.2.4 NOISE POLLUTION CONTROL

This subsection contains guidelines for allowable noise, an inventory of expected noise sources during the White River Shale Project, planned controls, and a comparison of regulations and emissions.

4.2.4.1 Regulations, Standards, and Criteria

Although no local noise regulations exist, state and federal regulations and guidelines regarding both occupational (employee) and community noise will apply to the project.

Employee noise exposure limits are promulgated by the Federal Occupational Safety and Health Administration (OSHA), the Utah Occupational Safety and Health Administration (UOSHA), and the Mine Enforcement and Safety Administration (MESA). These regulations are explained briefly in Table 4.2-7.

Table 4.2-7

OCCUPATIONAL NOISE REGULATIONS

Agency	Law	Effect
Occupational Safety and Health Administration (OSHA)	Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Subpart G, 36 FR 10466, May 29, 1971	Establishes noise exposure limits for workers; these limits are a function of intensity and duration of exposure
Mine Enforcement and Safety Administration (MESA)	Public Law 191-173, Subpart B, Section 70.300-5	As above
Utah Occupational Safety and Health Administration (UOSHA)	Utah Safety Rules and Regulations, Part 1910.95	Identical to OSHA regulations with the exception of an addendum that allows UOSHA to request audiometric testing if there is evidence of hearing damage

Community noise guidelines and criteria (Table 4.2-8) are offered by the Department of Housing and Urban Development (HUD) and the Environmental Protection Agency (EPA).

Table 4.2-8

COMMUNITY NOISE GUIDELINES AND CRITERIA

Agency	Document	Effect
Environmental Protection Agency (EPA)	Information on Levels of Environmental Noise Requisite to Protect Public Health and Safety, March 1974	Establishes recommended community noise level criteria
Dept. of Housing and Urban Development (HUD)	Noise Abatement and Control: Departmental Policy, Implementation Responsibilities and Standards, August 4, 1971. Circular 1390.2	Uses cumulative distribution noise levels to determine suitability of an environment for residential buildings

A more detailed outline of both occupational and community regulations is included in Section 4 of the Summary of Environmental Regulations and Guidelines (Ref. 46).

4.2.4.2 Noise Sources

The project will have three major types of noise: construction, operation, and traffic.

Construction Noise Sources. Major noise sources and corresponding untreated equipment noise levels during construction are shown in Table 4.2-9.

Table 4.2-9

CONSTRUCTION NOISE LEVELS
FROM TYPICAL UNTREATED EQUIPMENT

Equipment	@ Operator Position	@ 50 Feet
Earth-moving equipment	80-105 dBA	75-95 dBA
Drilling	95-112 dBA	80-97 dBA
Blasting	90-115 dB[(a)]	135 dB

(a) Peak sound pressure levels

Operation Noise Sources. In operation of the facility, noise will be generated by mining and processing. Since the noise sources associated with each differ considerably, they are listed separately in Tables 4.2-10 and 4.2-11.

Table 4.2-10

MINING: TYPICAL ESTIMATED UNTREATED EQUIPMENT
NOISE LEVELS

Equipment	Operator Position (dBA)
Drills	80-104
Scalers	85-103
Roof bolters	85-106
Loaders	85-108
Blasting	(90-140 dB peak)
Trucks	85-98
Crushers	105-115
Vibrating screens	95-110
Ventilation fans	70-95[(a)]

(a) No operators; noise level at 50 feet

Table 4.2-11

PROCESSING: TYPICAL UNTREATED EQUIPMENT NOISE LEVELS

Equipment	@ 3 Feet (dBA)
Atmospheric relief and vent valves	100-140
Control valves and piping systems	80-100
Cooling towers and forced draft coolers	85-95
Blowers and fans	85-110
Compressors	95-110
Pumps	80-105
Motors	80-105
Gears	80-100
Solids conveyance equipment	75-115
Rock crushers	100-110
Vibrating screens	100-110
Trucks	90-110
Steam turbine	85-95
Flares	110-130

Traffic Noise Sources. Traffic noise will come from employee passenger cars and supply trucks. The volume of traffic will vary throughout the construction periods as will the traffic noise. The L_{50} noise levels (noise levels exceeded 50 percent of the time) caused by project-related traffic are projected to be in the range of 28 to 53 dBA at the nearest residence in Bonanza.

4.2.4.3 Control Equipment and Procedures

A variety of generalized techniques exist for controlling equipment noise; these will be used independently or in combination to achieve the desired control. These techniques are generally applicable in controlling both

occupational and community noise. They can be used to control noise at its source, prevent its transmission, or isolate the receiver from the noise and include the following:

- Acoustical absorbing materials inside buildings, cabs, and enclosures
- Lagging (acoustical wrapping or cover)
- Equipment enclosure that may be close fitting, walk-in, or room
- Barrier wall
- Quiet equipment
- Silencers and mufflers
- Vibration isolation
- Vibration damping
- Personnel enclosures and cabs
- Personnel walkways
- Personnel access restriction
- Personnel exposure time reduction
- Personnel relocation

Noise generated by equipment can affect both occupational and community noise levels. Since the community impacts from the noise of construction and operation of the facility are expected to be insignificant, these techniques are expected to be directed largely toward limiting occupational noise exposures.

Construction Noise Control. Employee noise exposures during construction will be limited by a variety of methods including using quiet construction equipment, administratively controlling working patterns and locations, and wearing hearing protectors when engineering and administrative controls are inadequate or infeasible.

The peak sound pressure level, or peak overpressure of blasting noise, will be controlled by regulating the amount of explosive and by burying the explosive.

Operation Noise Control. Since the equipment used in the operation of the facility can be considered permanent or semipermanent in use and design, more specific noise control procedures can be outlined for the operation phase than for the construction phase.

Mining. Mining noise control is discussed in Subsection 3.5.7.

Processing. Processing will involve a great variety of equipment noise sources. Both the type and extent of noise control required will depend on location, operating parameters, employee work patterns, and available technology.

An equipment noise specification program will be used to reduce noise from some original equipment and will establish limits on noise emissions of large equipment. The equipment layout of the facility will be reviewed to establish equipment locations that optimize employee noise isolation where feasible.

Other engineering controls of major noise sources that may be considered during the design stage of the facility include the following:

- Atmospheric Relief and Vent Valves. Locating safety valve and relief valve systems at a great enough distance from exposed personnel will permit normal distance and air attenuation noise reduction from the noise source to any potential exposed personnel. Quiet valves and vent silencers will be used when necessary.
- Control Valves and Piping Systems. Noise will be reduced by using in-line silencers and specifying and installing low-noise valves. Pipe lagging will also be used as required.

- Air-Cooled Heat Exchangers and Cooling Towers. Air cooler noise can be reduced by reducing fan tip speed, improving blade design, and increasing the number of fan blades. Air cooler fan tip speed will be low enough to satisfy in-plant noise level requirements. The plant will be laid out with cooling towers away from normally occupied areas.

- Blowers and Fans. Silencers on fan inlets and outlets, enclosures, and lagging will be used as needed.

- Compressors. The maximum permitted noise level for purchased compressors will be specified. Measures that may be used to reduce noise include: inlet and discharge pipe silencers, low-noise types of valves, antisurge bypass systems, and noise-attenuating casings or enclosures. Motor drives will be of the low-noise type. Gear reducers may require acoustical enclosures.

- Large Pumps or Multistage Rotary or Cavitating Pumps. It may be necessary to lag or acoustically enclose such equipment to reduce noise.

- Motor Noise. There are wide differences in noise generation between motors of different types; size alone is not a reliable guide. As a general rule, large standard high-speed motors (3,600 rpm) are excessively noisy. Unless the noise is properly attenuated, the combined effect of the large number of motors located in plant areas can produce a significant noise level. Quiet low-speed motors will be used where possible, and provisions for fan silencers and acoustic enclosures will be made as required.

- Gears. Gear train noise will be reduced by the use of vibration isolation and enclosures where required.

- Solids Handling Equipment – Belt and Pneumatic Conveyors. Impacts of solids on solids and on equipment metal will cause vibrations and noise. Such noise will be reduced by minimizing solid free-fall, adding vibration dampening material to metal panels, and using acoustical lagging and acoustical enclosures as required.

- Rock Crushers. The operator will be provided with an acoustical enclosure that will allow him to monitor and control the rock crushers in a low noise level environment.

- Vibrating Screen Housings. Vibrating screen housings will be treated with vibration damping material to reduce radiated noise. Sound absorbing and lagging materials and vibration isolation systems will be used as required.
- Haulage Trucks. Noise will be controlled by using mufflers and sound attenuated cabs. Noise control planning for the entire plant will consider truck loading station locations, truck traffic routes, and truck scheduling.
- Steam Turbine-Generators. Turbines will have acoustic enclosures.
- Flares. Flare noise will be reduced by employing flame subdivision at the burners. Seal drums will be equipped with antislosh baffles to prevent combustion pulsations. Elevating flares will reduce exposure to workers on the ground.

Because of design limitations, these engineering controls will sometimes not sufficiently limit employee noise exposures, and in such cases, administrative controls will be used. Such controls include the manipulation of employee schedules and work locations. Normally trafficked and manned areas where excessive noise levels exist will also be posted.

During special or infrequent maintenance operations requiring access to noisy areas, hearing protectors will be used to limit noise exposures.

Areas of excessive noise unforeseen during the design stage of the facility will be pinpointed through noise surveys, and additional or alternative noise control procedures can be adopted if indicated.

4.2.4.4. Comparison Between Regulations and Controlled Emission Rates

Occupational. All employee noise exposures will be controlled to minimize occupational hazards to hearing and to comply with both OSHA and MESA regulations outlined in the Summary of Environmental Regulations and Guidelines (Ref. 46).

Community. Community noise levels without specific control procedures will be well within "acceptable" ranges outlined by both HUD and EPA criteria (see Ref. 46) and marginally above ambient levels during some periods (see Subsections 5.2.6.3, 5.2.6.6, and 5.2.6.9).

Traffic Noise. Community noise resulting from traffic may be lessened by reducing the volume of employee vehicle traffic to and from the facility. This will be accomplished by encouraging bus transportation or car pools; however, even without such measures, the resulting community noise still falls in the "normally acceptable" range of HUD criteria.

Section 4.3

Section 4.3

SOLID WASTE DISPOSAL PLAN

This section presents the solid waste disposal plan. Particular emphasis is placed on procedures for assuring the protection of the environment and compliance with waste disposal regulations.

4.3.1 REGULATIONS, STANDARDS, AND GUIDELINES

The Oil Shale Lease Requirements and the federal and state regulations governing the disposal of solid waste are summarized in Section 7 of the Summary of Environmental Regulations and Guidelines (Ref. 46). The regulations and guidelines pertaining to solid waste disposal include:

- Federal Oil Shale Lease: Environmental Stipulations, Sections 9C, 14B, 14C, 14D, and 14E
- United States Environmental Protection Agency: 40 CFR Part 241
- Utah State Department of Social Services, Division of Health: Title 26, Chapter 15, Part 5, UCA, 1953, as amended July 17, 1974

Pertinent requirements for the design and operation of the disposal site are:

- Disposal will be through sanitary landfill.
- Sites will be planned and operated to minimize erosion and landslides.
- Fill methods reflecting the best practicable system will be used.
- Finished surfaces will be revegetated.

- Saline and toxic drainage will be prevented from contacting ground and surface water resources.
- All plans, disposal sites, and procedures will be approved by the Area Oil Shale Supervisor and the Utah State Division of Health.

4.3.2 WASTE SOURCES

Various types and quantities of solid waste, other than overburden and processed shale, will be produced during the construction and operation phases of the project. Tables 4.3-1 and 4.3-2 list the solid waste sources and quantities expected during the major phases of the project. The quantities of solid waste shown in the tables are approximate and will be revised when engineering information becomes available.

4.3.2.1 Single Retort Phase (Phase II)

Construction. Typical kinds of waste construction materials expected during the 3-year construction period are shown in Table 4.3-1. Miscellaneous waste such as general trash and garbage will be generated by construction workers and field personnel. The small amount of used lubricants may be economically salvageable.

Mine and Plant Operation. Mining of raw shale is expected to reach a production level as high as 10,000 tons per calendar day (TPCD) by the time of single retort facility startup. The dust collected from the primary crusher will be the major waste and will be left in the mine. Shop and warehousing activities in the mine will result in small amounts of miscellaneous wastes along with employee-related trash and garbage. Waste quantity estimates listed in Table 4.3-1 are based on a shale production rate of 8,700 TPCD.

Table 4.3-1

SUMMARY OF MAJOR SOLID WASTES, SINGLE RETORT PHASE

Waste Source	Type and Major Constituents	Approximate Quantity Generated		Waste Collection and Storage	Waste Disposition
		As Produced	As Disposed		
Single Retort Facility Construction (3-year period)					
Various construction activities	Construction debris – lumber, packing, concrete, scrap metal, etc.	3 TPD (avg)	3 TPD	Collected in twenty 45-cubic-yard bins; load directly on trucks	Picked up and hauled by truck to landfill site for deposition
Equipment maintenance	Waste oils	Small amounts	Small amounts	Collected in drums for salvage	Hauled away periodically for reclaiming or disposal
Employee facilities	General trash and garbage	0.4 TPD (avg)	0.4 TPD	Collected in one 3-cubic-yard bin	Picked up and hauled by truck to landfill site for deposition
Single Retort Phase Mining (8,700 TPCD)					
Primary crushing	Raw shale dust (50% moisture)	2.2 TPD (dry)	4.4 TPD (wet)	Wet scrubber and settling tank	Pumped to disposal site in mine
Shop warehouse employee facilities	General trash and garbage	0.2 TPD	0.2 TPD	Collected in one 3-cubic-yard bin	Taken to surface and hauled by truck to landfill site for deposition
Single Retort Facility Operation (2 1/2-year period)					
Secondary crushing and screening	Raw shale dust (95% moisture)	6.5 TPD (dry)	130 TPD (wet) (22 gpm)	Wet suppression and scrubber	Slurry pumped to processed shale moisturizer; conveyed to processed shale disposal site
Retort raw shale feeding	Raw shale dust (95% moisture)	0.43 TPD (dry)	8.5 TPD (wet) (1.5 gpm)	Wet scrubber and settling tank	Slurry pumped to processed shale moisturizer; conveyed to processed shale disposal site
Retort processed shale discharge	Processed shale dust (95% moisture)	0.35 TPD (dry)	6.9 TPD (wet) (1 gpm)	Wet scrubber and settling tank	Slurry pumped to processed shale moisturizer; conveyed to processed shale disposal site
Water treatment facility	Water treatment filter solids (99% moisture)	Small amounts	Small amounts	Settling tank	Slurry pumped to processed shale moisturizer; conveyed to processed shale disposal site
Stretford unit	Elemental sulfur slurry (50% moisture)	2.3 TPD (dry)	4.6 TPD (wet)	Centrifuged sulfur reslurried with water in a holding tank	Put on processed shale conveyor for disposal with processed shale
Shops, warehouse, and employee facilities	General trash and garbage	0.2 TPD	0.2 TPD	Collected in one 5-cubic-yard bin	Picked up and hauled by truck to landfill; spread and covered
Sanitary wastewater treatment	Digested biological sludge	Small amounts	Small amounts	Stored in drying beds for future use	Used for soil conditioning during revegetation
Equipment maintenance/ lab/gravity separator	Waste oils, chemicals, skimmed oils	Small amounts	Small amounts	Collected in drums for salvage	Fed to retort or hauled off-tract for reclamation

Table 4.3-2

SUMMARY OF MAJOR SOLID WASTES, COMMERCIAL PHASE

Waste Source	Type and Major Constituents	Approximate Quantity Generated		Waste Collection and Storage	Waste Disposition
		As produced	As disposed		
Commercial Mine and Plant Construction (4-year period)					
Various construction activities	Construction debris — lumber, packing, concrete, scrap metal, etc.	15 TPD (avg)	15 TPD (avg)	Collected in twenty 45-cubic-yard bins; loaded directly on trucks	Picked up and hauled by truck to landfill, spread, and covered
Shops, warehouse, and employee facilities	General trash and garbage	2 TPD	2 TPD	Collected in one 5-cubic-yard bin	Picked up and hauled by truck to landfill, spread, and covered
Equipment maintenance	Waste oils	About 1 ton per week		Collected in drums for salvage	Hauled away periodically for reclaiming or disposal
First-Train Commercial Mining (80,400 TPCD)	During commercial mining for the first train, about one-half as much waste will be produced as during full commercial mining (see below). The waste sources, types, and disposition will be the same as below.				
First-Train Commercial Plant Operation (50,000 BPCD)	During first train operation, about one-half as much waste will be produced as during full commercial plant operation (see below). The waste sources, types, and disposition will be the same as below.				
Full Commercial Mining (160,800 TPCD)					
Primary crushing	Raw shale dust (95% moisture)	40 TPD (dry)	800 TPD (wet) (133 gpm)	Wet scrubber and settling tank	Slurry pumped to disposal site in mine
Equipment maintenance	Waste oils	About 1 TPWk		Collected in drums for salvage	Hauled to slop oil tanks for reclaiming
Shops, warehouse, and employee facilities	General trash and garbage	2 TPD	2 TPD	Collected in one 5-cubic-yard bin	Taken to surface and hauled by truck to landfill site for deposition
Full Commercial Plant Operation — First and Second Train (100,000 BPCD)					
Secondary crushing and screening	Raw shale dust (95% moisture)	120 TPD (dry)	2,400 TPD (wet) (400 gpm)	Wet suppression and scrubber	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Raw shale feeding to vertical retorts	Raw shale dust (95% moisture)	6.8 TPD (dry)	13.3 TPD (wet) (22 gpm)	Wet scrubber and settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Processed shale discharge from vertical retorts	Processed shale dust (95% moisture)	5.5 TPD (dry)	10.5 TPD (wet) (2 gpm)	Wet scrubber and settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site

Waste Source	Type and Major Constituents	Approximate Quantity Generated		Waste Collection and Storage	Waste Disposition
		As produced	As disposed		
Full Commercial Plant Operation – First and Second Train (100,000 BPCD) (Cont'd)					
Raw shale feeding to fines-type	Raw shale dust (95% moisture)	2.4 TPD (dry)	47 TPD (wet) (8 gpm)	Wet scrubber and settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Fines-type retorts	Attrited alumina balls	700 TPY (average)		Discharged from retorts along with processed shale	Conveyed along with processed shale to processed shale disposal site
Fines-type retort pre-heater exhausts	Raw shale dust (95% moisture)	360 TPD (dry)	7,180 TPD (wet)	Wet scrubber and settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Fines-type retort ball elutriators	Processed shale dust (95% moisture)	30 TPD (dry)	594 TPD (wet)	Wet scrubber and settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Fines-type retort processed shale moisturizer exhaust	Processed shale dust (95% moisture)	1.9 TPD (dry)	38 TPD (wet)	Wet scrubber and settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Crude shale oil hydrotreaters	Spent HDN catalyst (nickel-based proprietary; arsenic trapped in top portion of bed)	1,300 TPY (avg)		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed
Naphtha hydrotreater reactor	Spent HDN catalyst (cobalt-molybdate based)	8 TPY (avg)		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed.
Hydrogen plant	Catalyst support (Alundum balls)	84 TPY (avg)		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed.
Hydrogen plant guard bed reactor	Spent guard bed catalyst (zinc sulfide-zinc oxide)	see below		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed.
Hydrogen plant HDS reactor	Spent HDS catalyst (cobalt-molybdate based)	see below		Special handling procedure; transferred to air tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed.

Waste Source	Type and Major Constituents	Approximate Quantity Generated		Waste Collection and Storage	Waste Disposition
		As produced	As disposed		
Full Commercial Plant Operation – First and Second Train (100,000 BPCD) (Cont'd)					
Hydrogen plant H. T. shift converter	Spent catalyst (iron-chromium oxides)	see below		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed
Hydrogen plant L. T. shift converter	Spent converter catalyst (copper-zinc oxides)	see below		Special handling procedure; transferred to air tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed
Hydrogen plant primary reformer	Spent reformer catalyst (nickel-based)	see below		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed
Hydrogen plant methanator	Spent methanation catalyst (nickel-based)	see below		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed
Hydrogen plant	Total spent catalysts	325 TPY (avg)		Special handling procedure; transferred to air-tight trans-portable container	Either hauled to landfill site, moisturized, spread, and covered; or reclaimed
Hydrogen plant Benfield solution filter	Deactivated carbon filter cake (adsorbed hydrocarbons)	27 TPY (avg)		Drained and dumped into liquid-tight transportable containers	Hauled to landfill site, moisturized, spread, and covered.
Sulfur plant Claus unit reactors	Spent Claus unit catalyst (deactivated alumina)	34 TPY (avg)		Drained and dumped into liquid-tight transportable containers	Hauled to landfill site, moisturized, spread, and covered.
Amine plant DEA filter	Diatomaceous earth filter cake (absorbed hydrocarbons)	57 TPY (avg)		Drained and dumped into liquid-tight transportable containers	Hauled to landfill site, moisturized, spread, and covered.
Amine plant DEA filter	Deactivated carbon filter cake (adsorbed hydrocarbons)	18 TPY (avg)		Drained and dumped into liquid-tight transportable containers	Hauled to landfill site, moisturized, spread, and covered.

Waste Source	Type and Major Constituents	Approximate Quantity Generated		Waste Collection and Storage	Waste Disposition
		As produced	As disposed		
Full Commercial Plant Operation – (100,000 BPCD) (Continued)					
Stretford unit	Elemental sulfur slurry (50% moisture)	85 TPD (dry)	170 TPD (wet)	Centrifuged sulfur	Either hauled to landfill site, spread and covered; or reclaimed
River water treatment	Water treatment sludge (99% moisture)	3 TPD (dry)	300 TPD (wet)	Settling tank	Pumped to processed shale moisturizer; conveyed to processed shale disposal site
Sanitary and process wastewater treatment	Digested biological sludge (80% moisture)	0.5 TPD (dry)	2.5 TPD (wet)	Stored in drying beds for future use	Used for soil conditioning
Process wastewater treatment	Skimmed oils (50% moisture)	15 TPD	30 TPD (wet) (5 gpm)	Pumped to slop oil tanks	Reclaimed
Equipment maintenance, laboratory	Waste oils and chemicals	1 TPWk		Collected in drums for salvage	Disposition dependent on chemical or oil
Shops, warehouse, employee facilities	General trash and garbage	5 TPD	5 TPD	Collected in one 5-cubic yard bin	Picked up and hauled to processed shale landfill area, spread, and covered

The single retort facility will produce operations-related waste. Dust will be collected from secondary crushing and screening units and from the retort. These dusts will be similar in composition to their respective parent materials. The Stretford unit, treating low-Btu gas, will produce low-grade elemental sulfur in cake form. Because of its quality, this sulfur will be disposed of as solid waste. Small amounts of waste sludges will be produced from water treatment, wastewater treatment, and wastewater oil skimming. Other miscellaneous waste, such as plant trash and garbage, will result from plant employee activities during the single retort facility operation. All of these wastes will be disposed of in the landfill.

4.3.2.2 Commercial Operation Phases (Phases III and IV)

Construction. During the 4-year period of first- and second-train construction, field activities will be similar to those of the single retort construction, but on a larger scale. Hence, sources and types of solid waste will also be similar. As indicated in Table 4.3-2, the solid waste quantities reflect the larger field construction force and the larger quantities of construction materials.

Mining. The solid waste sources and types will be the same as those from Phase II mining. Table 4.3-2 indicates the waste expected from two-train (160,800 TPCD) mining operations. About half as much waste will be produced at the 80,400 TPCD mining rate for first-train operation.

Plant Operation. Table 4.3-2 lists the expected waste sources and quantities for two-train plant operation. As indicated in this table, first-train operation will produce about half as much solid waste as full commercial operation.

Shale dust collected in various air pollution control facilities will constitute about 80 percent of the total solid waste. Dust collection facilities will include scrubbers for secondary crushers, retort feed and discharge points, processed shale moisturizers, ball elutriators, and raw shale preheaters.

Other routine waste will include elemental sulfur from the Stretford unit, sludge from water treatment, skimmed oil and biological sludge from wastewater treatment, and general plant trash and garbage.

Some waste will be produced intermittently, such as spent catalysts, catalyst support, and exhausted filter cake materials that are replaced periodically. As indicated in Table 4.3-2, there will be nine different spent catalysts: two from the hydrotreaters, six from the hydrogen plant, and one from the Claus sulfur plant. Cycle times range from 1 to 5 years. Spent filter cake materials — deactivated carbon (hydrogen plant and amine plant) and filter aid (amine plant) — will be replaced several times a year.

4.3.3 WASTE HANDLING, STORAGE, AND DISPOSAL SYSTEMS

The handling, storage, and disposal of solid waste will be carried out in a manner that will protect public health and safety and the environment. Solid waste will be put in containers suitable for temporary storage. Waste will be picked up on a regular schedule and transported to the disposal site in the processed shale disposal area.

4.3.3.1 Single Retort Phase (Phase II)

Waste from Construction. Various sizes of bulk containers (10, 20, 40 cubic yards) will accumulate and store construction waste until picked up. General trash and garbage will be put in small, leakproof container bins equipped with tight-fitting covers to prevent littering or attracting

vectors. Other materials, such as waste chemicals, oils, or oily materials, will be put in leakproof, fireproof containers for temporary storage. The placement of containers, their number and type, and the frequency of pickup will vary during the construction phases.

Construction waste will be trucked to the processed shale disposal area and landfilled. An all-weather access road to the landfill site (in a side canyon on the eastern ridge of Southam Canyon) will be developed as part of site preparation for processed shale disposal. Water spraying equipment will control dust on the access road and at the site.

Landfilling by the area method will probably be employed. Solid waste discharging at the working face will be spread, compacted in shallow layers, and covered. Excess construction overburden may be used for cover material; if this material is not available, local material will be used. Cover material will be sufficiently deep to minimize rain water percolation and to prevent animals from burrowing into the waste layers. A catchment constructed west of the initial processed shale disposal area will collect any runoff or leachate from the disposal area. This landfill will be buried by processed shale during Phase II operation.

Waste from Operation. Process-related waste will be handled somewhat differently than construction waste. Waste collected in slurry form will be used along with water to moisturize processed shale and will go to the disposal area on the processed shale conveyor and processed shale hauling vehicles. Slurry waste includes raw and processed shale dust collected in wet scrubbers, water treatment filter sludges, and Stretford unit sulfur. Waste will be transported in closed systems from source to the truck loading bin located in the processed shale disposal area.

Other solid waste, such as trash and garbage from the mine and the plant area, will be handled in a more conventional manner. It will be accumulated in bins or other appropriate containers and picked up regularly by collection vehicles and transported to the deposit site. Digested biological sludge will be stored in drying beds for possible later use as a soil conditioner. Waste oils and chemicals will be collected in drums; the collected material will be either fed to the retort, hauled off site for reclamation if feasible, or buried in the processed shale pile.

Solid waste disposal will be part of the processed shale disposal and its associated environmental control activities. Waste trucked to the disposal sites will be spread, compacted, and covered with processed shale. The processed shale cover will be several feet thick and will be compacted to minimize percolation and leachate generation.

Procedures for control of dust, erosion, surface runoff, and leachate from the processed shale disposal area will meet environmental protection standards. (For details, see Section 3.10.)

4.3.3.2 Commercial Operation Phases (Phases III and IV)

Waste from Construction. Construction waste from mine development and plant construction will be handled in the same manner as in the single retort construction phase. The quantities of waste will be larger and the sources more widespread. Container distribution and waste pickup frequency will be commensurate with the sources, types, and quantities of waste being generated throughout this construction phase.

Construction waste will be landfilled in Southam Canyon and buried by processed shale during commercial plant operation. The landfill operations and associated environmental control procedures will be basically the same as those used in the single retort construction phase. The

landfill area will be located away from major drainage channels in Southam Canyon to minimize potential interference with surface water movement.

Waste from Commercial Operation. During first-train operation, process-related waste as well as waste from second-train construction will be handled. Waste collection procedures used during the single retort operation phase will be applicable throughout Phases III and IV. In the latter phases, provisions will be made for handling increased quantities.

Solid waste collected in the plant and mine (except slurry waste) will be trucked to the processed shale disposal area. As in the single retort operation phase, dust collected in various air pollution control facilities — all in slurry form — will be added to the processed shale and transported by covered or closed conveyors to the processed shale disposal area.

During commercial operation, solid waste will be landfilled using the same procedures as in the single retort operation phase.

Spent catalysts will contain material such as arsenic, nickel, chromium, etc. Catalyst manufacturers or licensors have developed safe handling procedures that will be used during the periodic changeout of these materials. Catalysts such as high nickel hydrotreater catalyst will be transported off site for reprocessing of suitable contracts can be arranged. Otherwise, all catalysts will be buried. Water sprays will suppress dust and moisturize the material as it is deposited. Catalysts will be covered immediately and the cover compacted.

4.3.4 SUMMARY OF DISPOSAL PLAN

The solid waste disposal plan is intended to comply fully with the applicable environmental stipulations in the Federal Oil Shale Lease and with the Utah State Code of Solid Waste Regulations. In summary:

- Solid waste will be put in approved containers for temporary storage.
- Solid waste will be picked up regularly and transported in appropriate collection vehicles to the disposal site.
- Slurry waste will not be landfilled directly but will be used to moisturize processed shale.
- Special handling and disposal procedures will be used for potentially hazardous materials.
- Solid waste will be disposed of in the processed shale disposal area using accepted landfill techniques (spread, compact, cover).
- Disposal sites in the processed shale disposal area will be located to minimize effects from natural drainage channels and groundwater.
- Adequate equipment and manpower will be maintained at the disposal site to conduct the landfill operation and to provide effective dust, litter, and vector control.
- Any surface runoff or leachate from the disposal area will be impounded and monitored (part of the processed shale disposal plan).
- The processed shale pile, containing the solid waste, will be landscaped and revegetated.

The solid waste monitoring plan is described in Section 6.4.

Section 4.4

Section 4.4

WATER POLLUTION CONTROL

4.4.1 PROTECTION OF EXISTING WATER RESOURCES

4.4.1.1 Avoidance of Disturbance During Construction

As discussed in Subsection 3.19.6, all on-tract construction activities will be planned to avoid lowering the quality of surface and subsurface water sources. Catchment basins and runoff diversions, protective measures for controlling seepage and percolation, and maximum reuse of wastewater will result in negligible discharge of contaminated runoff to natural surface and subsurface water bodies.

4.4.1.2 Avoidance of Disturbance During Operation

All operation activities of the White River Shale Project will be planned to result in zero wastewater discharge. All waste streams and contaminated runoff from the process area will be diverted to catchment basins. The streams will then be treated and reused in the process activities for dust suppression. Runoff from Southam Canyon, including the processed shale disposal area, retained by the Southam Canyon retention dam and the processed shale will be used for dust control and processed shale compaction at the disposal site. Slope dressing and planting procedures in the processed shale revegetation program are designed to catch and retain all precipitation (up to the 100-year storm) that falls directly onto the finished pile surface. This water will be available for reuse by the vegetation.

Aspects of water drainage and erosion control for the project are discussed in greater detail in Section 4.5.

Water supply systems will result in water withdrawal from the White River (estimated average pumping rates) of 5,000 to 10,000 gpm during Phase III and 8,000 to 16,000 gpm during Phase IV (see Section 7.14 in Part 7 of this DDP).

4.4.2 REGULATIONS, STANDARDS, AND GUIDELINES

A sound wastewater management plan will be adopted by the White River Shale Project to prevent water pollution from the project. The goals of this management plan are listed below:

- Zero discharge of wastewater
- Optimum use of water and wastewater
- Judicious selection of treatment facilities
- Compliance with all applicable regulations

The plan is described in detail in Section 3.15. Alternative plans and the rationale for selection of the proposed action are discussed in Section 7.15. This subsection (4.4.2) summarizes the legal requirements, wastewater sources, and control procedures.

4.4.2.1 Legal Requirements

The construction and operation of the wastewater treatment facilities are governed by the following two main regulations:

- Bureau of Land Management, Sale of Oil Shale Leases (U-25918, U-26194, and amendments). The lease, with its environmental stipulations, is the main document regulating the White River Shale Project activities. The Lessee is required to:
  - Comply with all applicable federal, state, and local water pollution control and water quality regulations
  - Conserve the mineral and other resources (including water)

  - Avoid, minimize, and repair damage to the land, water, and air
  - Take all measures to protect the health and safety of all persons affected by activities of the lessee

- Utah Code of Waste Disposal Regulations (as authorized by the Utah Water Pollution Control Act – Utah Code Annotated, 1953, Title 73, Chapter 14, as amended). The code contains specifications and design criteria for wastewater collection and treatment facilities.

Regulations pertaining to wastewater discharge specifications and permits are not strictly applicable to the WRSP since the proposed wastewater management plan calls for zero discharge. These regulations include:

- Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.), mainly Sections 301 and 402
- Utah Water Pollution Control Act (Utah Code Annotated, 1953, Title 73, Chapter 14, as amended), specifically discharge permits required under Section 73-14-5
- Code of Waste Disposal Regulations, Part II, Appendix A, "Guidelines for Formulating Water Quality Standards for the Interstate Waters of the Colorado River System"
- EPA "Colorado River System Salinity Control Policy" Title 40, Chapter I, Part 120
- Colorado River Basin Salinity Control Forum, "Proposed Water Quality Standard for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control," June 1975

A detailed summary of all pertinent environmental regulations is presented in Section 6 of the Summary of Environmental Regulations and Guidelines (Ref. 46).

4.4.2.2 Wastewater Sources

The wastewater streams will include sanitary wastewater from employee facilities and a variety of streams from the mining, retorting, and upgrading facilities (see Table 4.4-1). Sources and characteristics are discussed in Section 3.15 and Subsection 3.19.6.4.

4.4.2.3 Control Procedure

The proposed wastewater management plan (discussed in Section 3.15) includes schemes for wastewater collection, treatment, and reuse.

Table 4.4-1

WASTEWATER SOURCES
(gpm)

Wastewater Streams	Single Retort Operation		Commercial Operation		
	Construction	Operation	Construction	First-Train	Two-Train
Sanitary wastewater	(a)	10	50	25	45
Sour water	—	25	—	630	1,250
High TDS	—	10	—	380	755
Oily washdown	—	20	—	150	290
Storm runoff	40(b)	40(b)	45(b)	45(b)	45(b)
Saline mine water	Nil	Nil	Nil	Nil	Nil

(a) Contractor chemical toilets will be used.
(b) Acre-feet of expected surface runoff during the 100-year storm.

Wastewater streams will be segregated, collected, and treated according to types of contaminant. The use of optimum treatment systems is planned to achieve zero discharge through total wastewater reuse. The treated wastewater is reused as makeup to the scrubbers for the secondary crushers. Later, the wastewater is reused again to wet the processed shale. Figure 4.4-1 shows a simplified overview of the proposed control plan.

4.4.3 REMOVAL OF OIL AND OTHER HAZARDOUS MATERIALS

This subsection discusses plans to prevent spills of oil and hazardous materials. Implementation of the plans minimizes the threat of pollution to waterways.

4.4.3.1 General

Spill prevention will be achieved by the following activities:

- Designing facilities and equipment to preclude spills, insofar as practicable
- Training personnel in proper and safe operation procedures, good housekeeping and maintenance practices, and awareness of spill potential
- Scheduling regular inspection and maintenance of facilities and equipment

Preventive and emergency cleanup measures are amplified in Section 4.11, "Oil and Hazardous Materials Spill Contingency Plan."

4.4.3.2 Facility Drainage

Oil traps or skimmers will be inspected regularly for oil accumulations. The accumulated oil will be returned to storage or disposed of by approved methods. Runoff from contaminated areas will be collected and deoiled (see Section 3.15). Details of the plant drainage scheme are presented in Subsection 3.13.3.

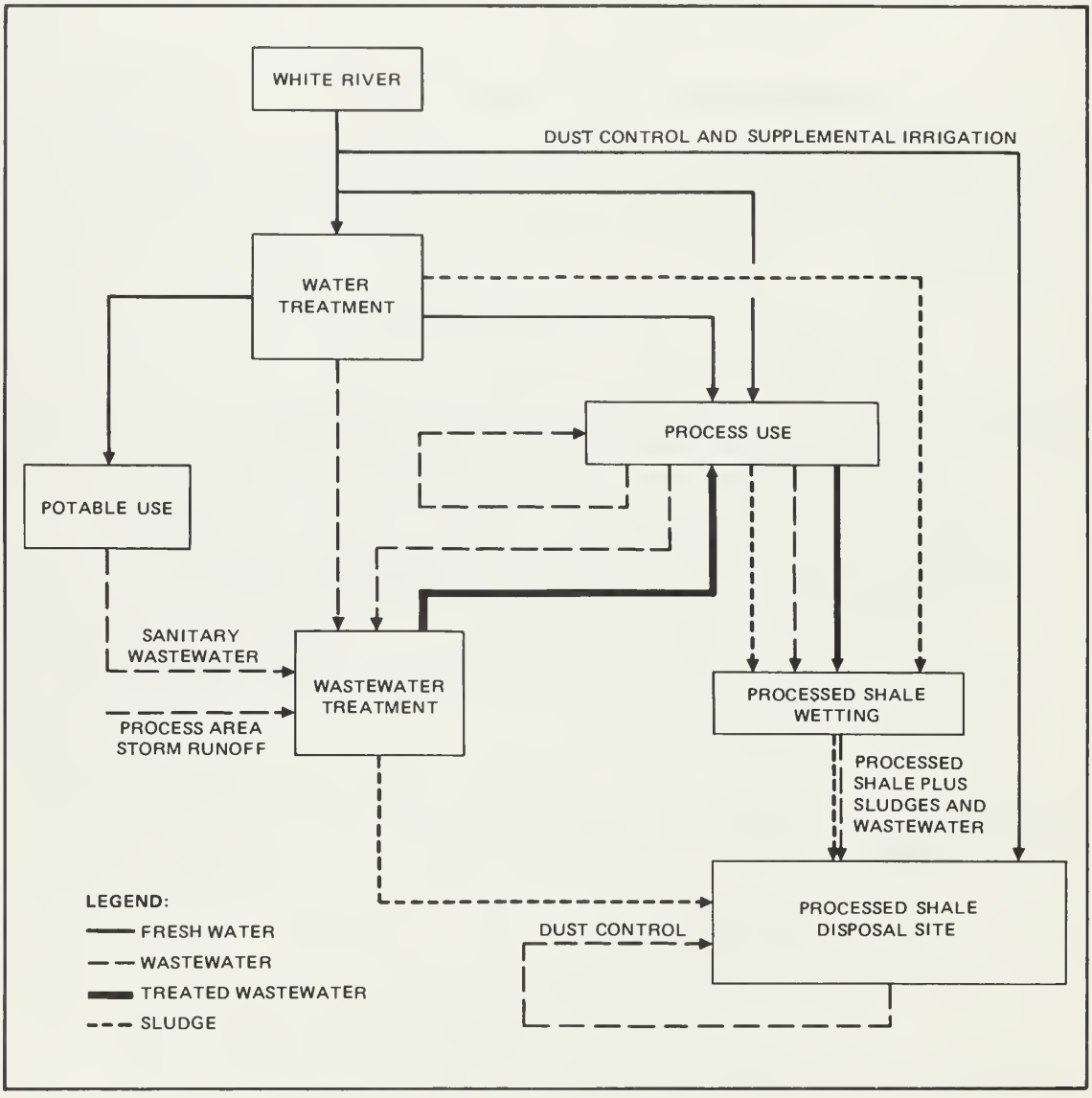


Figure 4.4-1. Overview of Wastewater Management Plan

4.4.3.3 Storage Tanks

Oil storage tanks will be designed, built, and tested in accordance with all applicable regulations and will be compatible with the materials stored. Spill prevention features incorporated into tank design will include adequate sizing, use of overflow lines, adequate vacuum or overpressure protection, and a liquid-level sensor.

As an added protective measure, a diking system will be included in the facilities design. For Phase II operations, a holding basin will be sized in accordance with the lease stipulations to contain more than 150 percent of all combined tankage, plus the runoff from a 100-year storm. For Phase III and IV operations, dikes located immediately downgrade from storage tanks are sized to retain 100 percent of the combined liquid contents of the tanks that they serve. The holding basin downstream from the dikes will provide a capacity equal to the remaining 50 percent of the total tank capacities, plus the runoff from the 100-year storm. This spill protection system is designed to meet the requirements of the oil shale lease. It should be pointed out, however, that this system far exceeds normal petroleum industry practice (see National Fire Protection Association Flammable and Combustible Liquids Code, 1973) and that the White River Shale Project will request from the U.S. Government relief from this excessive lease stipulation. This protection system is designed to meet requirements of the Oil Shale Lease (see Section 6 of the Summary of Environmental Regulations and Guidelines).

Diked storage areas will have manual valves that will be normally closed. The retained stormwater will be analyzed before each draining to the wastewater treatment plant. If there is enough oil on the water surface to permit skimming with vacuum pumps, such oil will be recovered

before the water is drained. All tanks will be visually examined regularly to detect conditions that may require maintenance.

4.4.3.4 Transfer and Fueling Operations

The White River Shale Project will maintain an equipment fueling station and tanker truck loading-unloading facilities where the following spill prevention measures will be observed:

- All piping, pumps, and meters will be protected from equipment and rolling stock by posted signs and physical barriers.
- Tanks will not be filled beyond rated capacities.
- Tank vents will be kept free of blockage.
- All fuel tanks will be clearly marked as to type and grade of product.
- Equipment records for each tank will reflect all operating data and repairs.
- All valves will be checked before starting any pumping operation to ensure that they are properly positioned.
- "No Smoking" signs will be placed in various locations to provide necessary warning.
- Fueling hoses and valves will be inspected regularly and repaired or replaced if necessary.
- Operators will be responsible for assuring that vehicles being refueled or transferring fuel do not move until the operation is complete and all hoses and valves are secured.

4.4.3.5 Personnel

All personnel involved with petroleum products or hazardous materials will be instructed in spill prevention measures, as described in Section 4.11, "Oil and Hazardous Materials Spill Contingency Plan."

4.4.4 PESTICIDES AND HERBICIDES USE PLAN

There are presently no plans to use pesticides or herbicides on Tracts U-a and U-b. During construction, vegetation will be removed by mechanical means. After the completion of the earthwork, it may be necessary to control vegetation in order to reduce fire hazards around the facilities. In this arid region, natural establishment of vegetation may be so slow and vegetated areas so sparce that mechanical control will suffice. However, should the growth of vegetation over extensive areas pose a fire hazard, the mechanical control may have to be supplemented with periodic applications of herbicides. If the use of herbicides is warranted, the following procedure will be employed:

- The need for pesticide or herbicide use, the area of application, and the duration of treatment will be identified.
- An EPA-approved pesticide applicator will be engaged as required.
- The plan for pesticide-herbicide use will be submitted to the Area Oil Shale Supervisor for approval.
- The methods of application, storage, and disposal of pesticide-herbicide will be examined to assure that they are in accordance with applicable state and federal regulations.

Garbage and kitchen wastes from employee support facilities will be confined to closed receptacles to prevent flies and similar pests from posing a substantial problem. In midsummer, during periods with little wind, biting midges can be very troublesome to man and animal, particularly in the vicinity of the White River, and it may be necessary to control these pests in localized areas to assure continued productivity of the work force.

Section 4.5

Section 4.5

WATER DRAINAGE AND EROSION CONTROL

4.5.1 DESIGN RATIONALE

Of the total of 10,240 acres on Tracts U-a and U-b, a drainage area of approximately 5,300 acres will be directly affected by processing and disposal activities during the life of the White River Shale Project. Table 4.5-1 gives a breakdown of the acreage disturbed by the various construction and operation activities. Surface runoff and erosion control will be required for all of these areas and their associated subdrainages.

The drainage system and erosion control design concepts for the entire project will provide an integrated system of control and conveyance facilities designed to:

- Prevent contamination of the natural waterways
- Prevent or limit erosion of the terrain and reduce the need for extensive sediment retention
- Maximize the use of drainage waters for vegetation and project use

The principal areas for drainage consideration are the plant and process areas, the processed shale disposal areas, and the relatively undisturbed contributing drainage areas. All these principal areas will be affected during the single retort operation phase, the commercial operation phases, and decommissioning. Drainage will be controlled during each project phase by dams, ditches, stabilizing techniques, seepage control measures, surface grading, and revegetation.

Observations at the site have provided information on sediment transport. These observations, together with estimates for Utah obtained from the U.S. Department of Agriculture (Soil Conservation Service), were used to estimate the volumes of sediment that may be deposited in the various project compounds. No data were available regarding the sedimentation characteristics of processed shale. A sediment storage volume equal to approximately 10 percent of the design flood runoff was assumed for sizing the impoundments. The actual volume will be determined during project design.

Lease stipulations require that impoundments be of adequate size to retain the runoff from a 100-year flood. In developing the configurations of the drainage facilities, the 100-year flood was taken into consideration. Design of embankments classified as dams will be consistent with current dam engineering and safety practices in the United States.

The design of the retention dam in Southam Canyon will take into consideration the total area of the canyon's drainage basin. As the canyon is filled with processed shale, the collective drainage area will decrease so that, at decommissioning, the dam storage capacity will exceed that required by the lease stipulations. The wastewater and storm runoff holding basin storage volume will be designed to meet the requirements specified in the lease (see Subsection 4.5.2.2). The freshwater reservoir's storage capacity will be sufficient to meet the requirements of project use, maximum storm drainage, and sedimentation for the life of the project.

4.5.2 DRAINAGE CONTROL PLAN

The control of water movement during construction and operation, both on the ground surface and on and within the processed shale pile, is discussed in this subsection. Table 4.5-2 and Figure 4.5-1 present a summary of the control features of the drainage program.

Table 4.5-1

DISTURBED AREAS –
WHITE RIVER SHALE PROJECT

Types of Disturbance		Single Retort (Acres)	First Train (Acres)	Two-Train (Acres)	Total (Acres)	Paved[a] and Built-Over Areas Including Dam Pools (Acres)	Areas[a] Revegetated During Operation (Acres)
Access Roads[b]		44	–	–	44	20	22
Utility Corridors[c]		11	31	–	42	–	42
Processed Shale Landfill and Conveyance[d]		130	119	2,046	2,295	7	2,183
Single Retort Phase Dam[d][e]	Dam[f]	3	–	–	3	–	3
	Pool[f]	19	–	–	19	19	–
Southam Canyon Retention Dam[e]	Dam[f]	–	6	–	6	–	5
	Pool[f]	–	35	–	35	35	–
Process Site							
Tank farm		1	14	–	15	9	–
Tank farm emergency dikes		–	23	–	23	–	23
Wastewater holding basin	Dam[f]	3	1	–	4	–	4
	Pool[f]	6	4	–	10	10	–
Freshwater reservoir[e]	Dam[f]	–	4	–	4	–	–
	Pool[f]	–	9	–	9	9	–
Process pad, roads, buildings, sulfur product shipping and NH_3 storage, etc.		26	74	–	100	75	12
Mining adits and shafts, stockpiles, changehouse, secondary crushing, etc.		8	10	1	19	16	3
Mine Vent Shafts and Excavation Landfill		–	3	<1	3	–	3
Total Disturbed Area		251	333	2,047	2,631	200	2,304

(a) Total of these columns do not agree with "Total Disturbed Area" because owing to fire hazards, some slopes may not be revegetated. Also, some areas revegetated during the single retort phase will be filled over during construction of commercial-scale units.
(b) Areas for access roads include allowances for an electric utility line.
(c) Single retort phase 6-inch freshwater pipeline includes an allowance for an electric utility line.
(d) Single retort catchment is filled over during first-train operation. Commercial operation disturbances are calculated for first-train disturbances and two-train disturbances.
(e) Pool areas for all impoundments except freshwater reservoir are maximum design areas.
(f) Dam areas indicated are the areas left exposed when maximum design pool is impounded.

Table 4.5-2

SUMMARY OF DRAINAGE CONTROL FEATURES

Feature	Location	Type	Drainage Area (acres)		
			Phase II	Phases III and IV	Decommissioning
Single retort phase dam[a]	Mouth of side canyon	Embankment	500	N/A	N/A
Southam Canyon retention dam	Mouth of Southam Canyon	Embankment	–	4,840	200
Upper Southam Canyon catchment basin	South face of the processed shale pile	Embankment	N/A	≈ 2,300[b]	≈ 2,300
Wastewater and storm runoff holding basin	North of plant site	Embankment	490	350	350
Freshwater reservoir	South of plant site	Embankment	N/A	110	110
Processed shale vegetation program	Surface of pile	Craters	N/A	Variable	≈ 2,500
	Side slopes of of pile	Side slope catchments	N/A	Variable	680

(a) All dams will be built with sufficient capacity to satisfy lease stipulations and be commensurate with dam safety design practices in the United States.
(b) To be constructed after approximately 5 years of operation.

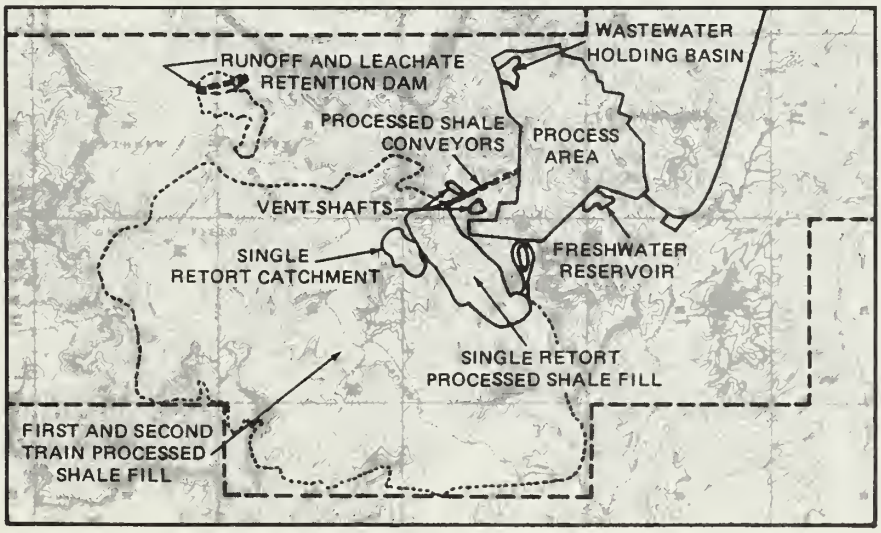


Figure 4.5-1. Drainage Control Features

4.5.2.1 Processed Shale Disposal

Phase II. During Phase II, processed shale will be placed in a side canyon on the eastern slope of Southam Canyon, as discussed in Section 3.10.4. Surface and subsurface runoff from this shale pile will be intercepted by the single retort phase dam built across the mouth of this side canyon. Small berms may be necessary in the northeastern part of the disposal area to ensure that contaminated flows are prevented from entering the unprotected drainage basin to the east. A 4:1 slope will be used to reduce erosion of the processed shale side slopes. A select rock drain will be placed as required at the slope toes to carry drainage flows and to prevent erosion of the shale material. A significant portion (about 90 percent) of the natural drainage of Southam Canyon will not be interrupted. Storm runoff that does not contact the processed shale will be allowed to continue to flow directly to the White River. Surface drainage from the processed shale will be transported off the pile by surface culverts and ditches, and directed to the catchment.

If the project is abandoned at this stage, the surface contouring and revegetation procedures for erosion control discussed in Section 4.6 will be applied to the processed shale pile.

Construction of the single retort phase dam located downstream from the processed shale pile will maximize the use of local materials. It will be built during construction of the single retort facility, and it will provide sufficient capacity to contain the runoff of a 100-year storm from a drainage area of 500 acres. The dam will include a cutoff and foundation treatment to limit seepage. The location of the dam will allow the uncontaminated runoff from the remainder of the 4,850-acre drainage basin to flow to the White River. The dam will be abandoned when the project enters the commercial phase because it will be covered subsequently by processed shale.

In the event that the project is terminated before Phase III, however, the resulting drainage impoundment will then become an evaporation pond.

Phases III and IV. In Phases III and IV, disposal will proceed from the Phase II disposal site along the eastern ridge of Southam Canyon toward the southern limit of Tract U-a. In the early stages of production, the main drainage channel in Southam Canyon will be unrestricted in order to:

- Minimize drainage contamination
- Eliminate the need for additional drainage structures
- Ensure access to the alluvial materials for the revegetation program

To prevent contaminants from entering the White River, a retention dam will be built in the northern end of the canyon prior to the start of the commercial operation phase shale disposal. This dam will be an embankment-type structure consisting, insofar as possible, of local materials. The dam will include a cutoff and foundation treatment to limit seepage underflow. As placement of the processed shale progresses across and down the canyon, a corresponding decrease in drainage area will occur, continuing until completion of the project. Any drainage water captured behind the dam during the life of the project will be regularly pumped out and used in the processing activities; standing water will be present behind the dam only for a day or two after a major storm.

Surface runoff from the processed shale pile drainage will be controlled by two techniques. The first involves contouring the top surface of the processed shale pile into a series of large depressions (or craters) that will retain all precipitation. The second technique is the installation of catchment basins over the slopes of the pile designed to capture rainfall in quantities up to 2.4 inches in 24 hours (100-year storm). These two techniques, part of the revegetation program (discussed in Subsection 4.6.2), are expected to nearly eliminate runoff from the finished pile.

Because the potential evapotranspiration requirement of 48 inches per year greatly exceeds the predicted annual rainfall, and because of the field capacity, (i.e., moisture retention) of the processed shale, the volume of percolating water is expected to be insignificant. The expected field capacity of the processed shale is about 20 percent by weight. Since the water applied for dust suppression and compaction will provide about 10 percent by weight, a residual 10 percent by weight of moisture must be provided by excess storm runoff before water movement (percolation) can occur.

Drainage from the upper portion of Southam Canyon will eventually be interrupted by the shale disposal. A blanket of local materials may be placed, as required, on the southern exposed slopes of the shale pile to retard the percolation of surface runoff water from the off-tract portion of Southam Canyon through the shale pile. At decommissioning, the uncontaminated water that will collect following rain storms will be allowed to evaporate.

Decommissioning. For a discussion on decommissioning refer to Subsection 3.21.3.1.

4.5.2.2 Process Facility and Other Areas

General Erosion Control Methods. All construction and operations work will be conducted in accordance with applicable federal and state regulations and the directives of the Area Oil Shale Supervisor. Removal of vegetation will be limited to that which is absolutely necessary to prepare the construction sites, to provide an adequate work area, and to meet safety requirements for unobstructed vision. Vehicular traffic will be confined to roads, except in actual work areas, and driving in stream beds and/or on slopes after rains will be discouraged. Rehabilitation will be accomplished in all disturbed areas as soon as practicable. Rehabilitation methods are described in Section 4.6.

After construction, disturbed and highly erodible areas will be restored to conform to the general topography of the adjacent undisturbed land. Water bars will be installed on slopes to direct rainwater to vegetated areas and to minimize erosion on the right-of-way. All disturbed areas having suitable soils will be revegetated.

Drainage and Erosion Control – Process Area. Cutting, filling, and reshaping of the land will be done during construction of the process and tank farm areas. These activities will be accompanied by appropriate drainage control measures: temporary diversions, interceptor ditches, berm shoulders, dikes, etc. These control measures will be built to prevent runoffs from eroding cut-and-fill slopes; water bars will be constructed to protect long slopes; and, where alternative sites are available, construction on steep slopes will be avoided.

Large portions of the process and tank farm areas will be built over a paved pad (see Table 4.5-1), and drainage control structures will be incorporated into the design for these areas (see Subsections 3.13.3 and 3.13.5). Downstream from the process and tank farm areas, an embankment-type dam capable of storing about 75 acre-feet will be constructed at the beginning of the single retort phase.

This dam is described in Table 4.5-2. As required by the lease stipulation, the resulting holding basin will be designed to contain the following:

- 100-year storm runoff
- Sediments for the life of this project phase
- Wastewater and minor oil contaminants
- 150 percent of the tank storage volume

At the start of commercial operation, the dam crest will be raised and the basin excavated to accommodate the increase in tankage and wastewater volumes as required by the above criteria and as discussed in Subsection 4.4.3.3.

The freshwater reservoir south of the process area will be of value in runoff and erosion control. Its principal purpose will be to provide on-tract storage of freshwater. At decommissioning, the reservoir will become an evaporation pond.

Raw shale stockpiles will be placed on a bed of relatively impervious local materials to minimize infiltration of the leachate. Berms will intercept contaminated surface runoff from these storage sites and collect it for use in process activities such as dust suppression.

Drainage and Erosion Control – Pipelines and Roads. During clearing operations for the water and product pipelines, vegetation will be stockpiled for later use as a soil stabilizer or as a mulch on revegetated areas. The cleared right-of-way will be wide enough to accommodate the pipe trench and to provide a suitable work area for pipelaying operations. (Widths of 50 to 100 feet are most common.) Grading of the right-of-way may be required to make the work area safe, particularly on severe slopes. The rate of clearing and grading will be coordinated with ditching, pipelaying, and backfilling operations to minimize the amount of disturbed (and hence erodible) land.

Because of the rocky terrain, backfilling the trench (after pipelaying) with a carefully selected combination of materials may be required. Suitable materials may be secured on tract or brought in from off tract. To reduce the likelihood of erosion, backfill material will be compacted to a density approximately equal to its density before excavation. Alternatively, a mound of backfill material may be left over the ditch to compensate for natural settling and compaction. Runoff diversion devices will be placed where needed on slopes to keep the backfill from being washed away. Upon completion of pipeline work, loose and unconsolidated material (which is subject to erosion) will either be compacted or removed from the right-of-way.

Streams that will be crossed by the pipelines on tract are small and intermittent. Whenever possible, pipeline construction will be carried out in dry periods when the crossings can be made by the open-trench method. If it rains during construction, stream-channel erosion resulting from construction activities will be minimized by routing runoff through diversion structures such as culverts.

Roads will be designed to allow storm runoff to follow the natural drainage courses as closely as possible. Culverts will be built under the new roads at natural drainage points to prevent water blockage. Culvert sizes will be chosen by taking into account the natural drainage's maximum expected runoff resulting from a 100-year storm. In the upgrading of existing roadways, natural drainage will be maintained by constructing additional culverts, if necessary.

Normal roadbuilding materials will be employed. To minimize the likelihood of leaching of objectionable materials, the choice of roadbuilding and maintenance materials will depend on where these materials will be used.

Rehabilitated surfaces in the pipeline and road easements will be stabilized and revegetated, as appropriate, as discussed in Section 4.6.

4.5.3 SURFACE AND SUBSURFACE DRAINAGE INTERACTION

Available data suggest that it is unlikely that the Bird's Nest Aquifer could be detrimentally affected by seepage from the processed shale, from on-tract impoundments, and from mining operations. A monitoring program as discussed in Subsection 6.3.2.1 will be implemented to detect any changes. The Bird's Nest Aquifer is confined and under artesian conditions within Tract U-a. Analysis of pumping test data indicates that the overlying confining materials have very low permeability. Moreover, when the overlying materials were drilled, they were dry and no water

was encountered until the Bird's Nest Aquifer was penetrated. These data furnish good evidence of the relative impermeability of the overlying materials. These materials act as a confining layer that restricts upward migration of water from the Bird's Nest Aquifer and retards downward movement from higher layers.

The small seepage that may percolate below the impoundment areas will first encounter the alluvial deposits. Groundwater seepage through these alluvial materials will be restricted, through design features of the dams, to that portion upstream from the catchment dams. Cutoff walls will be built through the alluvial materials to prevent any such seepage from migrating downstream to the flood plain of the White River.

Some dewatering will be required during mining operations, and the removal of oil shale could result in permanent changes in the structure of the aquifer-aquiclude materials (these changes are expected to be very slight). Dewatering during mining is expected to be minimal.

When the oil shale is removed, subsidence (however small) will cause physical changes in the overlying materials. The extension of the overlying materials into the mined zone and the resulting tension fracturing will tend to increase vertical permeability between the Bird's Nest Aquifer and the mined zone. Although this increase is not expected to be significant, it should be recognized and evaluated during the mine geotechnical studies. There is only a remote possibility of increased permeability through release of confining stress in the underlying materials.

Ultimately, subsidence due to mining will reach the ground surface. It should be very slight and relatively uniform over Tracts U-a and U-b, considering the depth of the mined zone and the expected minimizing of subsidence in the final pillar and mine design parameters. Nevertheless, monitoring the effects of this subsidence on the surface impoundments is necessary.

Section 4.6

Section 4.6

SURFACE REHABILITATION AND REVEGETATION

Section 11 (I) of the Oil Shale Lease Environmental Stipulations states that "The Lessee shall revegetate all portions of the Leased Lands which have been disturbed by his operations as soon as possible after the disturbance has ended in order to prevent, or, if prevention is impracticable, to minimize erosion and related problems. The Lessee shall restore the vegetation of disturbed areas by reestablishing permanent vegetation of a quality which will support fauna of the same kinds and in the same numbers as those existing at the time the baseline data was obtained under section 1(C) of these Stipulations." The White River Shale Project has developed the following program to comply with these stipulations.

4.6.1 REHABILITATION PLAN FOR DISTURBED AREAS

During peak construction and operation periods, approximately 275 acres of land on Tracts U-a and U-b (excluding the processed shale disposal site) will be disturbed. Of this total, permanent structures, road surfaces, reservoir surfaces, and areas that must remain clear of vegetation to avoid fire hazards will cover approximately 130 acres. The remaining disturbed area, approximately 145 acres, will be rehabilitated by restoring the land, as nearly as possible, to its natural state or to an appropriate productive state. Rehabilitation activities will include site cleanup and, where necessary, surface preparation and revegetation.

Land rehabilitation will begin soon after construction activities cease. Trash, garbage, leftover construction materials, and other debris will be removed to a sanitary landfill. Cleanup activities will be followed by

surface preparation and stabilization of critical areas, and the program will conclude with the reestablishment of vegetation through direct seeding. In some locations (e.g., lightly used areas where the vegetation has not been badly damaged and areas that support no natural vegetation), simple cleanup should suffice to restore the area to its natural state. Revegetation will not be attempted in rocky areas devoid of topsoil, or in areas where natural vegetation cover does not now exist.

In more severely disturbed locations, especially those where existing vegetation and topsoil have been removed, the intensive revegetation program detailed below will be implemented. Where only moderate disturbance has occurred, an intermediate program of revegetation will suffice to restore the land to a productive state. The degree of effort required to rehabilitate each disturbed location will be determined on a case-by-case basis.

The rehabilitation program for severely disturbed land areas is outlined below:

- Prior to construction, the aboveground portions of all woody plants will be removed from the areas to be disturbed, as described in Subsection 3.5.3. The removed plant material will be stockpiled at the edge of the disturbed area for future use.
- Where excavation or other severe disturbance is planned and the excavated material is unsuitable for supporting vegetation, the existing topsoil will be removed. Wherever possible, at least 6 inches of topsoil will be scraped off and stockpiled. After construction is completed, the stockpiled topsoil will be redistributed over the surface.
- Seedbeds will be prepared with disks, disk harrows, rollers, or other suitable implements, wherever practicable. The goal will be to prepare a surface that has 1 or 2 inches of loose topsoil and is firm below.

- Where vegetative debris is available, it will be shredded and applied to the surface as a mulch.
- Critical areas will be stabilized by applying a suitable straw or native hay mulch cover immediately after construction has ended. This mulch will be held in place by punching, disking, or applying a tacking compound.
- Soils deficient in nutrients will be fertilized. The need for fertilizer will be determined by soil testing and/or visual inspection.
- Seeding will be scheduled for late fall because: 1) soil moisture conditions are optimum at this time; 2) many seeds require winter chilling before they can germinate; 3) seed-collecting animals are less active during the winter; and 4) historically, in this region, fall seeding gives best results. Generally, each site will be seeded in the first fall following construction.
- Drill seeding will be used whenever seeding equipment can safely operate. Seed placement will be to depths of 1/2 to 3/4 inches in 6- to 8-inch rows. Broadcast seeding will be used only in areas that are inaccessible to drills. Following broadcast seeding, the seeds will be covered by light chaining or raking or some other suitable method.
- A typical seeding rate will be 20 to 25 grass seeds per square foot (or approximately 1 million seeds per acre). Shrubs will be seeded at the rate of 1 pound per acre. In critical areas and in areas where broadcast seeding must be used, these rates will be doubled.
- Those plant species will be selected for seeding that are adapted to climatic conditions of the area, that will be useful in controlling soil erosion, and that will provide grazing for big game and livestock. The mixture will consist of several grass and shrub species from the following list:

Fairway Wheatgrass	Agropyron cristatus
Pubescent Wheatgrass	Agropyron trachycaulum
Russian Wildrye	Elymus junceus
Alkali Sacaton	Sporobolus airoides consimilis

Squirreltail	Sitanion hystrix
Indian Ricegrass	Oryzopis hymenoides
Douglas Rabbitbrush	Chrysothamnus viscidiflorus
Rubber Rabbitbrush	Chrysothamnus nauseosus consimilis
Black Sagebrush	Artemisia nova
Big Sagebrush	Artemisia tridentata
Fourwing Saltbrush	Artriplex canescens

- Seeds used for revegetation will meet the quality standards of the Federal Seed Regulations. Certified named varieties, when available, will be used in preference to others. Seeds of commercially unavailable native shrubs will be obtained from seed collectors, under contract if necessary.
- Seeds will be treated with a fungicide if necessary to prevent damping off fungus.

4.6.2 PROCESS SHALE REVEGETATION PLAN

4.6.2.1 Introduction

In the absence of available revegetation technology, White River Shale Project has initiated a research program designed to obtain the required technology for establishing and maintaining vegetation on a processed shale surface. This ongoing research is being conducted by the Utah State University (USU) Agricultural Experiment Station under the direction of Dr. Cyrus McKell.* Revegetation of the processed shale presents unique problems due to the harsh characteristics of the arid, cold desert environment and because of problems posed by processed shale itself as a plant growth medium. Because of unforeseen results, it should be

*A detailed outline of this research is presented in a report accompanying the DDP, entitled Achieving Effective Revegetation of Disposed Processed Oil Shale: A Program Emphasizing Natural Methods in an Arid Environment (Ref. 48).

emphasized that the White River Shale Project revegetation plan, presented here as the USU method, is an ongoing research project, and as such represents the presently expected most probable approach. However, research alternatives will continue to be tested and evaluated until an optimum program is defined. The experimental program will extend into Phase III as necessary to refine its applicability to actual large-scale disposal conditions in Southam Canyon.

4.6.2.2 Principal Areas of Investigation

The following aspects of processed shale revegetation are being investigated:

- Shaping and sealing of the shale pile surface
- Selection of highly tolerant plant species
- Planting methods
- Colonization of the shale surface by established plants

Shaping and Sealing of the Shale Pile Surface. The shale pile surface can be shaped to shed water into soil-filled planting basins. This technique, known as water harvesting, leaches salts from or near the root zone of the plants and also increases the volume of rain retained in the root zone. Sealants or stabilizers will be applied to increase water-harvesting efficiency.

Selection of Highly Tolerant Plant Species. Native plant species (particularly shrubs) that tolerate adverse conditions (drought, salinity) in the processed shale are being selected, and techniques for propagating them are being developed.

Plant Methods. Older plants will be used for revegetation purposes since they are more tolerant than seeds or seedlings to salinity, drought, and high temperature.

Colonization of the Shale Surface by Established Plants. After the plants firmly establish themselves in the planting basins and the surface sealing treatment starts to lose its effectiveness, the plants will begin to colonize the entire area. This process will be encouraged with soil additives and fertilizers.

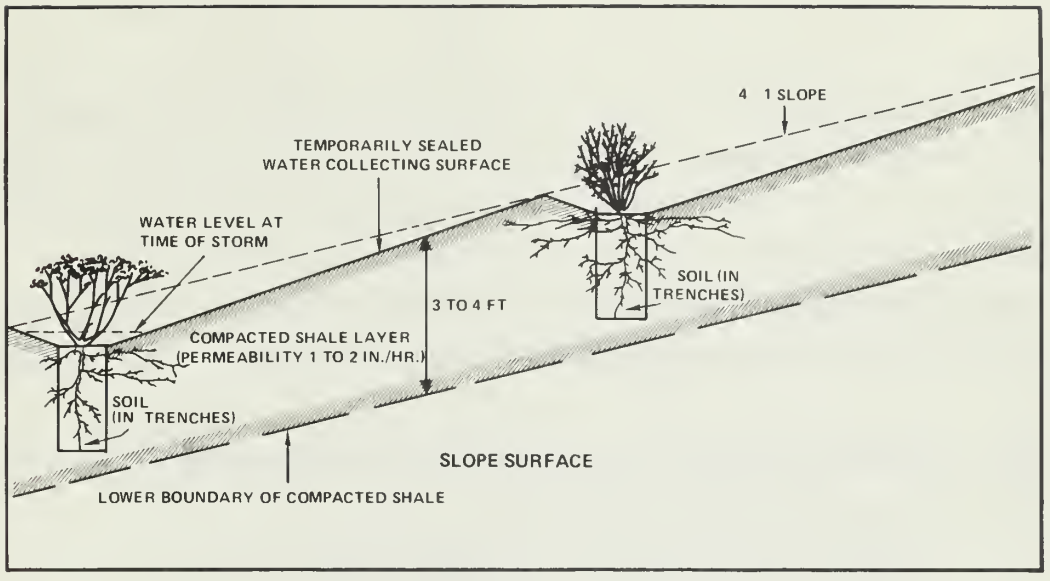
4.6.2.3 Field Application of the Proposed Revegetation Method

The following represents the most likely revegetation plan as it is presently envisioned. The plan is designed to incorporate a range of ideas within the present concept of existing conditions, and will be revised as technological developments occur.

Processed Shale Compaction. The shale's 3- to 4-foot surface layer would be crushed and compacted during disposal so that its coarse texture and high permeability would be reduced. During crushing and compacting, soil additives and phosphorus would be mixed in with the processed shale.

Planting Basins and Water-Harvesting Surfaces. The surface of the shale pile would be shaped to create planting basins and water-harvesting surfaces, as shown in Figure 4.6-1.

Each planting basin would contain a trench filled with topsoil reclaimed from the disposal site. These planting basins would be designed to retain all precipitation up to the amount received in the 100-year storm, thus minimizing or eliminating runoff from the processed shale disposal site. The water-harvesting surfaces would shed rainwater into the planting basins. These surfaces would be mechanically prepared and then treated with sealants and stabilizers to increase water-collecting efficiency and minimize erosion by water or wind. The surface-sealing treatment is designed to break down or become ineffective at about the time the plants are established in the soil-filled planting trenches.



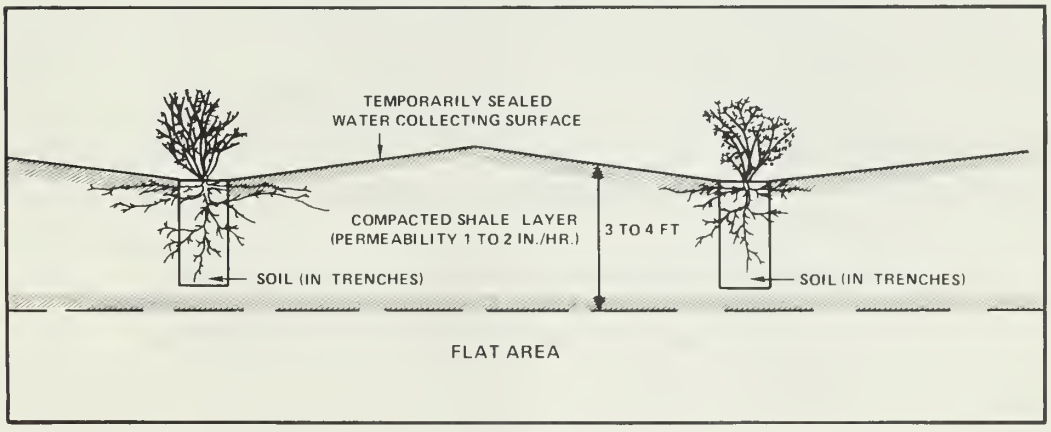


Figure 4.6-1. Surface Modification and Vegetation on Processed Shale (Conceptual – Not to Scale)

Plant Material Propagation. Plants would be propagated for the revegetation work by seeding, layering of cuttings, and transplanting. Specialized techniques, such as pretreatment of seeds or vegetative plant parts, may be required for the propagation of some shrub species. The effects of mechanical, chemical, and thermal seed treatment on germination and the effect of hormone treatment on cuttings are presently being studied.

Planting Techniques. After plant size and tolerance to adverse conditions were deemed adequate, plants would be transferred from the nursery and planted in the soil-filled trenches. Some plant species can be planted as bare-root seedlings, others as containerized seedlings of various sizes. The optimum age and size of the various plants at planting time would be determined by the present research program.

Plant Species List. In the selection of plant species, the following characteristics would serve as guidelines:

- The species is native to the region and therefore adapted to the climatic conditions of the site.
- It tolerates the physical and chemical conditions of the processed shale after the site has been prepared in the manner described earlier.
- It can be effectively propagated on a large scale.
- It provides habitat for the native fauna.
- If necessary, it resists overgrazing and persists on the site.
- It does not require prolonged maintenance and/or protection.
- It colonizes (invades) the processed shale surfaces after it has become established in the planting trenches and, in a reasonable time, improves the appearance of the disposal site.

Plants currently being studied and evaluated for the processed shale revegetation work are discussed in the USU report prepared under the direction of Dr. Cyrus McKell (Ref. 38).

Maintenance and Improvement of the Plantings. The color, physical composition, and chemical composition of the shale surfaces would have to be modified before they could be invaded by plants. To maintain healthy vegetation on the shale pile and to encourage colonization of the entire surface, fertilizers and other soil additives would be applied.

Emerging young plants are highly palatable, and grazing animals tend to concentrate on revegetated land. Thus, grazing by livestock would not be permitted until plants became well established and were able to resist vigorous pulling and trampling.

The revegetated portion of the processed shale pile would be protected from livestock grazing in one or both of the following ways:

- Making arrangements with the ranchers and/or Bureau of Land Management leaseholders to keep the livestock out of the area until the area can be grazed
- Erecting a fence around the revegetated area. Electric fencing or similar economical and effective fencing methods will be used, if necessary

Grazing big game on the tract is limited to occasional mule deer. If necessary, the revegetation area would be protected from mule deer by using repellents, sound systems, or, as a last resort, deer fencing. The tract is also inhabited by a number of small mammals that can attack and seriously damage new plantings. If damage due to these animals reaches sizable proportions, repellents and other acceptable control techniques would be applied.

4.6.2.4 Revegetation Schedule

Single retort operation in Phase II will result in a processed shale pile with a flat surface of 40 to 50 acres and with some sloping surfaces. It is planned that the flat surface of this pile, or a portion of it, will serve as a demonstration area for revegetation techniques. At the end of Phase II,

the entire flat surface will be revegetated, and at this point, if a decision is made to decommission the White River Shale Project, the entire pile, including slopes, will be revegetated.

After completion of commercial operation in Phases III and IV, approximately 2,300 acres of Southam Canyon will be covered with processed shale. Assuming that the volume of the disposed processed shale is proportional to the final surface area of the pile, approximately 115 acres per year for each of 20 years will require vegetation. It is planned that revegetation will follow the processed shale disposal as closely as conditions permit.

4.6.2.5 Soil Removal Program

A recent soil survey identified four soils and their complexes within the processed shale disposal site. A soil map indicating the locations of these soils is presented in Figure 4.6-2. Classification, textural name, depth, and acreage of these soils is shown in Table 4.6-1.

The soils indicated by map symbols "A," "As," and "Bs" occupy the largest portion of the site. "A" soil is a shallow channery loam; "As" soil is a shallow channery sandy loam; and "Bs" soil is a very shallow channery and flaggy sandy loam. These soils are located on moderate to steep slopes (5 to 50 percent) and have moderate to high erosion hazard.

All of these soils contain considerable amounts of rock fragments. For the "A" soil, rock fragment content is estimated at 25, 50, and 80 percent at 0 to 2.5, 2.5 to 8, and 8 to 18 inches depths, respectively.

"D" soil, the only deep soil of the area, is a sandy loam that occupies drainage ways below steep slopes and rock outcrops. Forming in alluvium from the Uinta Sandstone, this soil is strongly calcareous, alkaline

Figure 4.6-2. Map of Soils in the Tracts and Vicinity

Table 4.6-1

SOILS OF THE PROCESSED SHALE DISPOSAL SITE

Map Symbol Subgroup USDA SCS 1973* Classification	A Lithic Calciorthids	As Lithic Calciorthids	Bs Lithic Torriorthents	D Typic Torrifluvents	R
Soil texture	Shallow channery loams	Shallow channery sandy loams	Very shallow channery and flaggy sandy loams	Sandy loams	Rock-land
Depth, inches	12 to 20	12 to 20	2 to 10	60+	
Acreage in disposal area	95	652	737	453	358

*Soil Taxonomy, 1973, United States Department of Agriculture, Soil Conservation Service, Washington, D.C.

GLOSSARY

Channery	Soils that contain fragments of this flat sandstone, limestone, or schist up to 6 inches along the long axis
Flaggy	Soils that contain relatively thin fragments 6 to 15 inches long of sandstone, limestone, slate, or shale or rarely schist. A single piece is a flagstone
Loam	Textured class name for soils having 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand
Sandy Loam	Soil of the sandy loam class that has 50 percent sand and less than 20 percent clay

in patches, and moderately permeable, and it contains approximately 15 percent rock fragments. Although its depth to the bedrock is not known, it is not less than 5 feet.

Within the "D" soil area, smaller areas of flaggy sandy loams and channery sandy loams are also included. These soils are mainly near the heads of drainage ways; their depth varies from 25 to 35 inches.

The area classified as "R" (rockland) has no appreciable amount of soil.

Soil required for revegetating the processed shale will be obtained by removing "D" soil. All of this soil will be scraped off in front of the advancing shale pile and stockpiled until the amount of soil required for processed shale revegetation can be established. After that time, soil removal will be dictated by needs.

4.6.3 PROCESSED SHALE AS A PLANT GROWTH MEDIUM

To determine those properties of the processed shales that affect plant growth and to generate information on specifics of the White River Shale Project processed shale, a preliminary inquiry was made on the processed shale characteristics. The three major determinants of processed shale characteristics are: the retorting process, the temperature of retorting, and the composition of the raw shale. These factors vary for each site where oil shale is processed, and this variation results in a different processed shale type at each site.

Since White River processed shale is not available for testing, no direct evidence of its characteristics can be presented. However, to obtain preliminary information on the nature of White River processed shale, the following samples were analyzed and evaluated:

- Utah Fischer Assayed Shale. Raw oil shale from U-a and U-b was processed by the standard Fischer assay. This material is similar to the TOSCO processed shale.
- Calcined Shale. Utah Fischer assayed shale was heated to the Paraho process temperature (1,200°F).
- Paraho Processed Shale. This shale was mined in Colorado and retorted in Anvil Points.

Analytical results obtained on these samples were compared with data from the pertinent literature.

Analytical procedures for the processed shale characterization were generally those that are used for agronomic evaluation of soils or soil-like

materials. Because these tests correlate well with field results obtained on soils, it is useful to compare processed shale with soils. Such a comparison is given below.

4.6.3.1 Physical Properties

Size and Texture. The Paraho processed shale is a coarse material that consists mainly of the fragments of the crushed raw shale. It is expected that the White River processed shale will be similar to the Paraho sample. Processed shales are of loamy texture. This is a favorable texture class for soils, indicating that the material can adequately supply moisture to plants and provide a good textural environment for roots.

Field Moisture Capacity. Field moisture capacities of processed shale range from 16 to 20 percent by weight.

Permeability. Soil permeability indicates the rate at which the soil will permit the passage of water. It is expected that the White River shale will have high permeability, which can be reduced to acceptable levels (1 to 2 inches per hour) with compaction.

Resistance to Wetting. Resistance to wetting of TOSCO processed shale has been reported in the literature. Utah Fischer assayed and calcined shales and the Paraho shale samples have not indicated any resistance to wetting.

4.6.3.2 Chemical Properties

Salinity. Salinity starts to affect sensitive plants when the electrical conductivity of the saturation extract exceeds 4 mmhos per centimeter, and at 15 mmhos per centimeter agricultural crop production ceases. In the saturation extract of processed shales, electrical conductivity ranges

from 5 mmhos per centimeter to well over 20 mmhos per centimeter. It is expected that the salinity of the White River processed shale will be also within this range.

Cations. Undesirable sodic conditions are indicated when the ratio of sodium to calcium plus magnesium is high. All processed shales contain large amounts of sodium. The level of the calcium and magnesium ions seems to be influenced by the retorting process. Results indicate that the White River processed shale will be more sodic than other processed shales.

Anions. Carbonates and bicarbonates are undesirable ions and are less tolerated by plants than sulfates or chlorides. It is expected that the White River processed shale will contain high concentrations of carbonates and bicarbonates.

Boron. Boron is often present in toxic concentrations under sodic conditions. It is expected that the White River processed shale will contain high concentrations of boron.

Cation Exchange Capacity. Cation exchange capacity (CEC) of a soil is indicative of the rate at which a soil will supply nutrients to plants. Processed shales appear to have low cation exchange capacities, and it is expected that the White River shale will also have low CEC.

Major Plant Nutrients. Nitrogen, phosphorus, and potassium are the three major plant nutritional elements that are routinely assessed in fertility determinations of soils. It is expected that the White River processed shale will be deficient in nitrogen and phosphorus and will contain adequate amounts of potassium.

Total Soluble Salts. Total soluble salt content of processed shales varies from 0.6 percent to over 2.0 percent on a dry weight basis. The soluble salt content of White River processed shale is expected to be on the high side of this range.

Column Leaching. The ease of leaching White River processed shales under field conditions cannot be predicted at this time. But the data from the Paraho samples indicated that problems with the White River processed shale can be expected.

Chemical Reaction. In strongly alkaline soils, many nutrients are unavailable to plants, the general health is adversely affected, and only a few plants survive. Processed shales are alkaline and strongly alkaline. The Utah Fischer assayed and calcined shale samples and the Paraho sample were strongly alkaline, with pH ranging from 10.7 to 11.8. It can be expected that the White River processed shale will also be strongly alkaline.

4.6.3.3 Microbiological Properties

Chemical processes that take place in a soil, the availability of nutrients, and to some extent the existence of higher plants, depend on the activities of the soil microbes. The population of these microbes is determined principally by the soil's organic matter content. Processed shale leaving the retort has neither microbes nor organic matter, and unless organic matter is supplied to it, microbial activity will not start for a long time.

Section 4.7

Section 4.7

FISH AND WILDLIFE MANAGEMENT PLAN

The objective of the Fish and Wildlife Management Plan is to establish for the protection or restoration of the fish and wildlife habitat on the tracts procedures that are in accord with Section 4 of the oil shale lease environmental stipulations. The major elements of the plan are the identification of steps to be taken to avoid or minimize damage to fish and wildlife habitat and water supplies, to restore habitat that is unavoidably destroyed or damaged, to provide alternative habitat, and to provide controlled access by the public. The plan will be implemented just prior to Phase II construction and will be discontinued upon the decommissioning or abandonment of the project. The details of the plan and the schedule for implementation will be developed in response to factors such as:

- The results of the 2-year baseline study program
- The intensity of habitat disturbance during each phase of the project
- The development of a Fish and Wildlife Management Plan for the State of Utah dam on the White River
- The results of the ongoing monitoring program
- Any relevant shifts in land-use patterns or priorities, such as hunting or grazing

The details of the design and implementation of the plan will be developed in cooperation with the AOSS and in response to guidance from the State of Utah Division of Wildlife Resources, the U.S. Bureau of Land Management, and the U.S. Fish and Wildlife Service.

4.7.1 AVOIDANCE OR MINIMIZATION OF DAMAGE TO FISH AND WILDLIFE HABITAT

A primary consideration in the conceptual planning for the project, as presented in the DDP, has been to select from the variety of available alternatives an overall facility and operational design that minimizes the loss or damage of fish and wildlife habitat. The analysis of alternatives is presented in Part 7.

The balancing of environmental, economic, and other considerations has resulted in a facilities layout that will remove only small acreage of the more diverse riparian and shadscale habitats. The disposal of processed shale in Southam Canyon, while affecting a large area, will remove habitat of the more regionally abundant sagebrush-greasewood and juniper types. The impacts of these habitat disturbances are discussed in Section 5.4.

The terrestrial and aquatic habitats outside the immediate construction and processed shale disposal areas will be protected by pollution control systems and procedures. Descriptions and discussions of the environmental protection plans and their anticipated effectiveness are presented in Parts 3, 4, and 5, as follows:

- Air quality and noise pollution prevention
  - Control plan, Section 4.2
  - Air quality impacts, Section 5.2
  - Impacts on fish and wildlife, Section 5.4
- Water pollution prevention
  - Wastewater management plan, Section 3.15
  - Pollution control plan, Section 4.4
  - Drainage and erosion control, Section 4.5
  - Oil and hazardous materials spill contingency plan, Section 4.11
  - Water quality impacts, Section 5.3
  - Impacts on fish and wildlife, Section 5.4

4.7.2 RESTORATION OF UNAVOIDABLY DESTROYED OR DAMAGED HABITAT

As presently foreseen, loss or damage of habitat will occur in three primary localities (as shown in Figure 4.7-1):

- The process area
- Transportation corridors
- Southam Canyon

The rehabilitation and revegetation plan for disturbed areas in the first two localities is presented in Subsection 4.6.1. This program, a continuation of the revegetation program for disturbed baseline study sites, will be applied at any time through the life of the project where native soils are to be revegetated.

The processed shale revegetation plan is presented in Subsection 4.6.2. This plan summarizes an ongoing research program to study and optimize the variables in the water harvesting concept. The objective of the Surface Rehabilitation and Revegetation Plan is to establish a vegetative cover that will eventually be capable of perpetuating itself in normal conditions and of supporting wildlife of the same number and kind present before the disturbance occurred.

4.7.3 PROVIDE ALTERNATIVE HABITAT

An alternative habitat will be available to displaced species from the disturbed areas. By effectively raising the present productivity of the alternative habitat, it is anticipated that the average population levels of affected wildlife species will increase to levels approximating those presently observed over the entire tracts to compensate for those organisms that are unavoidably destroyed.

4.7.3.1 Size and Location of the Alternative Habitat

About 7,600 acres of undisturbed land on Tracts U-a and U-b are proposed as the alternative habitat for wildlife. The acreages of each vegetation type in the disturbed areas and in the alternative habitat are compared in Table 4.7-1. The affected areas for each project phase and the remaining alternative habitat are shown in Figure 4.7-1.

Table 4.7-1

APPROXIMATE ACREAGES OF EACH VEGETATION TYPE IN THE DISTURBED LANDS AND ALTERNATIVE HABITAT[a]

	Sagebrush-Greasewood	Juniper	Shadscale	Riparian	Totals
Tract U-a, acreage					
Disturbed lands	1,230	1,320	0	0	2,550
Alternative habitat	990	1,410	0	170	2,570
Tract U-b, acreage					
Disturbed lands	10	20	50	1	80
Alternative habitat	550	1,120	3,320	50	5,040
Totals for both tracts					
Disturbed lands	1,240	1,340	50	1	2,630
Alternative habitat	1,540	2,530	3,320	220	7,610

(a) Values listed above have been rounded off from corresponding values in Table 5.4-1.

The rationale for selecting the undisturbed land as an alternative habitat is based on five important factors:

- Availability of ecological baseline data from the tracts that provide estimates of the present composition and functioning of the ecosystem
- Availability of biological data from the monitoring program that will allow the continual assessment of the success of the fish and wildlife management plan

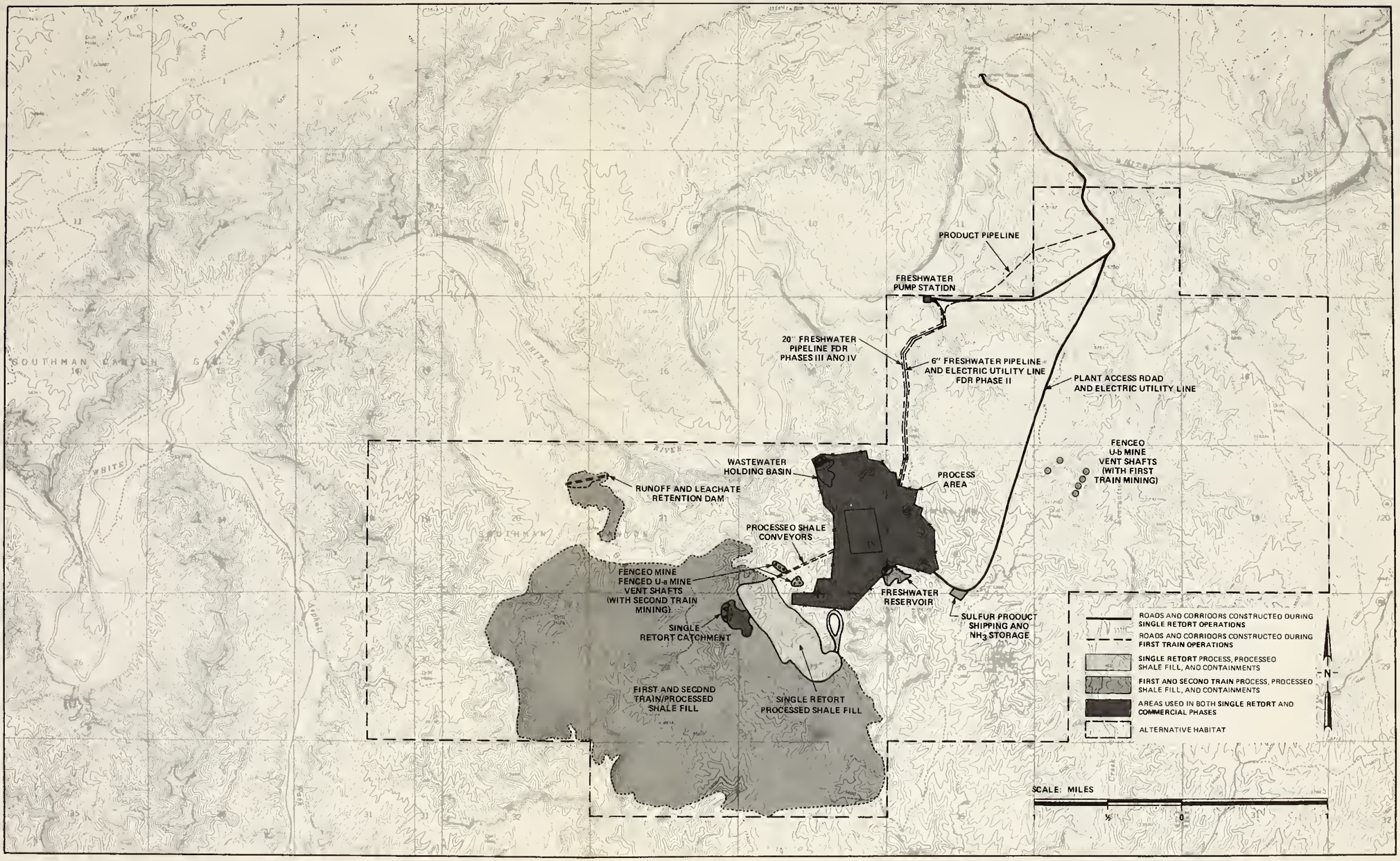


Figure 4.7-1. Location of Disturbed and Alternative Habitats

- The potential for adjusting present land-use management practice to minimize the need for expensive and difficult-to-maintain alternative enhancement techniques
- Availability of vegetation of like kind
- Proximity of the alternative habitat, offering immediate access and protection to displaced animals

As revegetation activities progress within Southam Canyon and elsewhere, rate of annual loss of available habitat will decrease and, as planned, the revegetated disturbed areas will contain a mixed plant association suitable for browsing by wildlife. Full utilization of the revegetated areas will not be realized, especially in Southam Canyon, until a self-perpetuating plant cover has become well established. The general schedule for revegetation, the acreage that will become available within the canyon and in other disturbed areas during the life of the project and at its termination, plant composition, and additional information regarding revegetated areas are discussed in Section 4.6 and in Ref. 48.

4.7.3.2 Habitat Enhancement

One of the most effective and practical means of habitat enhancement within this cold desert ecosystem is to reduce competition by reducing sheep grazing and allowing wildlife access to a portion of the vegetation presently consumed by livestock. As stated in Subsection 2.5.5, approximately 6,900 sheep graze on Tracts U-a and U-b from December to April. In addition, approximately 14,000 sheep "trail" through the lease area twice each year along Utah 45, the main county road on Tract U-b, and along Southam Canyon Road on Tract U-a. While precise estimates of the carrying capacity of the rangeland within the leased area are not available, field observations suggest that portions of the rangeland on and surrounding the tracts have been heavily grazed by sheep. A browse utilization study will be implemented during the second year of the baseline program to quantitatively evaluate the degree of grazing on the tracts by both native and domestic herbivores. If the data indicate that the

rangeland has been historically overutilized, White River Shale Project will recommend to the AOSO and BLM that grazing be reduced to levels that will allow the rangeland to recover and thereby support increased populations of wildlife.

Recent research in range management demonstrate that moderate grazing is beneficial in stimulating new shoot growth and in encouraging and maintaining a mixed grass/shrub community that offers a greater variety of forage and cover. This more diverse community benefits both native wildlife and domestic livestock (S. Clark Martin, Rocky Mountain Forest and Range Experiment Station, Tucson, Arizona; personal communication). Other studies suggest that adjusting the seasonal pattern of grazing may have similar beneficial effects. Laycock (Ref. 76) reports that heavy late-fall grazing by sheep following deferment of spring grazing improves deteriorated range condition. The result is the reduction of sagebrush and the encouragement of grasses and forbs. Heavy spring grazing tended to produce the opposite effect. It is evident from these and other range studies that a closely managed program of reduced or seasonally adjusted grazing can enhance the productivity of depleted rangeland.

With the decommissioning or abandonment of the project, the tracts will return to their former land uses. Any improvement of the range quality or productivity achieved during the implementation of the Fish and Wildlife Management Plan will benefit all long-term range users.

The White River Shale Project has held preliminary discussions of this general enhancement concept with the Utah Division of Wildlife Resources and the U.S. Bureau of Land Management. The Project is prepared to work with these agencies, through the AOSS, in achieving a Fish and Wildlife Management Plan that is responsive to the lease terms. If the present rangeland conditions are significantly depleted, it is assumed that it will take a number of years before an alternative habitat is established that could support increased wildlife populations. Therefore, to

be effective, any mutually agreed upon reduction of sheep grazing on Tracts U-a and U-b should begin before major disturbances occur or before Phase III is implemented.

It is recognized that off-tract disturbances such as the building of the White River Dam and other facilities will contribute to the displacement of wildlife populations. To survive the flooding of the riparian habitat, resident animals will be forced to move up or down the river canyon, or out onto the higher rangeland. The few species capable of surviving on the rangeland are expected to seek refuge within the planned alternative habitat. It is anticipated, therefore, that the alternative habitat will have to support existing wildlife populations as well as those displaced from on and off the leased tracts. It is also apparent that a totally new lacustrine environment will be created, parts of which will extend onto new tracts. The White River Shale Project will cooperate with the appropriate State and Federal agencies to develop a coordinated, compatible plan for the development and protection of fishery and wildlife habitats.

As the plan is developed, provision will be made for the on-tract installation of big game drift fences when and where necessary to direct big game around or away from construction and operation areas.

The biota monitoring program will be designed with the need to evaluate the success of the plan in mind. The monitoring program is discussed in Section 6.6.

4.7.4 PROVIDE CONTROLLED PUBLIC ACCESS

The White River Shale Project will provide the public with controlled access for enjoyment of the wildlife resources on such on-tract lands as may be mutually agreed upon with the AOSS. The Project proposes to implement a check-in procedure for visitors to the tracts. A visitor

sign-in sheet affixed to informational signs posted on roads at the tract borders would provide the following benefits:

- The visitors would be alerted to restricted areas where potentially hazardous conditions exist.
- They would be encouraged to conduct themselves in a manner that would protect the quality of the environment.
- They would be advised of the purposes of monitoring sites and equipment on the tracts and the importance of not disturbing them.
- They would be advised of the applicable laws and regulations governing hunting, fishing, and trapping.

As an adjunct to this public information program, the White River Shale Project will, if requested, cooperate with the Utah Division of Wildlife Resources in censusing hunter and fisherman use of the tracts.

4.7.5 POSTING OF NOTICES

It is recognized that the White River Shale Project has the opportunity and the obligation to instruct their employees of the applicable fish and game regulations. Printed notices advising all project-related employees of the laws and regulations governing hunting, fishing, and trapping will be posted in reasonable and conspicuous places. These notices may be supplemented with timely indoctrination programs if such programs are determined to be necessary or appropriate.

Section 4.8

Section 4.8

PROTECTION OF HISTORIC, PREHISTORIC, AND PALEONTOLOGICAL RESOURCES

The historic, prehistoric, and paleontologic resources located on Tracts U-a and U-b and their 1-mile buffer zone will either be avoided and protected, or excavated. Avoidance is preferrable, but when that is impossible, sites affected by construction or operation of the White River Shale Project will be excavated to salvage all material of interest. Many sites will require test excavations to determine if they are of any significance.

4.8.1 RESOURCE INVENTORY

As is pointed out in Section 5.6, there are no historic sites of any significance on the leased tracts. Table 4.8-1 describes each prehistoric site on tract as to contents, condition, and land ownership and lists the recommendations made by WRSP. Paleontological resources are described in Section 5.6.

4.8.2 PROTECTION PROGRAM

The mitigation program proposed for the on-tract prehistoric and paleontologic sites is described in the following paragraphs.

4.8.2.1 Prehistoric Resources

Table 4.8-1 presents recommended treatment of the archeological sites. Off-tract sites will be avoided. On tract, Sites 372 and 409 will be directly affected by Phase II construction. Site 372 is surface scatter only, and test excavations of it are not recommended. Conclusive collection

of surface finds, location recording, and site analysis has already been performed, and no further mitigation is recommended. The same applies to on-tract Sites 406, 408, and 324, which may undergo secondary impacts.

Construction activities may disclose new archeological data not evident from surface reconnaisance. A qualified archeologist at the site can ensure that all such data are recorded, salvaged, and appropriately analyzed. All on-tract archeological sites will be noted, and personnel will be instructed to avoid all unnecessary disturbance of them.

The employee indoctrination program will advise all personnel of federal and state laws prohibiting unauthorized removal or destruction of archeological resources both on and off tract.

4.8.2.2 Paleontological Resources

Before construction begins, samples will be taken from the most significant sites containing fossils for preservation, examination, and analysis. If fossils are encountered inadvertently during construction or operation of the White River Shale Project, a qualified paleontologist will be consulted to evaluate and salvage significant specimens.

Exposed significant fossils on-tract will be collected, and the remainder will be preserved and protected through an indoctrination program.

All employees on the White River Shale Project will be instructed not to remove or disturb any fossils either on or off tract and will be advised of federal and state laws prohibiting such unauthorized activity.

Table 4.8-1

PREHISTORIC RESOURCE INVENTORY

ON-TRACT SITES				
Site	Condition	Description	Land Ownership	WRSP Recommendation
42 Un 372	Undisturbed	Open site: surface scatter of lithic chipping debris; 100 m diameter	BLM	No further work
42 Un 373	Possible surface collections made previously	Open site: chipped stone and fire-cracked river cobbles; 100 ft x 100 ft	BLM	Avoid
42 Un 324	Undisturbed	Rock shelter: lithic chips, bone, charcoal; 130 ft x 12 ft	BLM	No further work
42 Un 408	Some potholes	Open site: single flake ca. 10-15 m length	BLM	No further work
42 Un 409	Probable surface collections made previously; some erosion	Rock shelter: 2 fire stains, possible depth of deposit; 5 m x 5 m	BLM	Evacuate test pit
42 Un 405	Probably some surface collections	Open site: chipping debris, sandstone slabs wall, three shallow pits; 100 m x 200 m	BLM	Avoid
42 Un 406	Eroded	Open site: bifaces, hammer-stone, historic debitage; 100 m	BLM	No further work

OFF-TRACT SITES				
Site	Condition	Description	Land Ownership	WRSP Recommendation
42 Un 118	Extensively vandalized but some undisturbed deposits remaining	Rock shelter: charcoal lenses and burned soil, corn cobs, chipping debris, charred animal bones, possible 2 m depth; 50 m x 15 m	State	Avoid
42 Un 355	Undisturbed	Rockshelter: surface scatter of fine chips, one notched point; 8 ft x 60 ft	BLM	Avoid
42 Un 356	Eroded	Open site: surface scatter of chipping debris; 25 m diameter	State	Avoid
42 Un 357	Eroded	Open site: chipping debris and single projected point; 5 m diameter	State	Avoid
42 Un 358	Eroded	Open site: single projectile point	State	Avoid
42 Un 365	No apparent potholes; shelter has been littered with historic debris	Rock shelter: masonry granary, one projectile point, burned bone, charcoal	State	Avoid

Table 4.8-1 (Continued)

OFF-TRACT SITES				
Site	Condition	Description	Land Ownership	WRSP Recommendation
42 Un 366	Extensively potholed	Rock shelter: pictographs, flakes, and chipping debris	State	Avoid
42 Un 367	Potholed; one 3-ft strip of deposit remains undisturbed; 10 ft long	Rock shelter: flakes and chipping debris	State	Avoid
42 Un 368	Undisturbed	Open site: chipping debris, one blade; 200 ft x 100 ft	BLM	Avoid
42 Un 369	Picked over but no potholes	Open site: chipping debris, fire cracked cobbles; 300 ft x 200 ft	BLM	Avoid
42 Un 370	Undisturbed	Open site: chipping debris, fire cracked cobbles; 300 ft x 100 ft	BLM	Avoid
42 Un 371	Undisturbed	Open site: fire blackened cobbles, etched slate petroglyph	BLM	Avoid
42 Un 374	Surface picked over; no potholes	Open site: chipped stone, fire-cracked and blackened cobbles; 100 ft x 100 ft	BLM	Avoid
42 Un 375	No obvious potholes	Open site: debris and fire-cracked cobbles; 100 ft x 150 ft	BLM	Avoid
42 Un 376	Undisturbed	Open site: chipping debris, projectile points; 20 ft x 20 ft	Private	Avoid
42 Un 377 (Thompson site)	Almost totally vandalized	Open site: considerable depth with charcoal, chipping debris, and fire blackened cobbles	BLM	Avoid
42 Un 378	No potholes but probably picked over	Open site: lithic debris; 200 ft x 200 ft	BLM	Avoid
42 Un 379	Eroded	Open site: chipping debris; and core fragments	BLM	Avoid
42 Un 380	Eroded	Open site: one projectile point	BLM	Avoid
42 Un 381	Potholed	Rock shelter: chipping debris	BLM	Avoid
42 Un 401	Some potting but mostly undisturbed	Open site: lithic debris, pottery, gray stone	State	Avoid
42 Un 402	Some potholes but good general condition	Rock shelter: flakes, scrapes, bifaces, and choppers	BLM	Avoid
42 Un 403	Good	Pictograph	BLM	Avoid
42 Un 404	Eroded	Rock shelter: possible projectile point or knife	BLM	Avoid
42 Un 407	Potholes	Rock shelter: charcoal and chipping debris exposed by potholes; 150 ft x 10 ft	BLM	Avoid

Section 4.9

Section 4.9

AESTHETIC VALUE CONSIDERATIONS

The design criteria adopted in project planning are primarily concerned with technical feasibility. Programs such as revegetation and recontouring of the land are primarily concerned with technical problems such as soil stabilization and erosion control, but they must also satisfy aesthetic considerations. The following measures are designed for the mitigation of adverse aesthetic impacts:

- The contours of the ridgetop-basin landscape unit will be utilized to locate the tankage farm, the shale storage tank, the retort facilities, and the facility as a whole within the natural topography.
- All facilities will be painted unobtrusive, natural colors consistent with the surrounding landscape, such as pastels and muted shades of brown, green, reds, or grays to blend with the desert-redrock canyon landscape. Only warning signs will be painted bright, unnatural colors.
- To the greatest extent possible, the natural openings of the land will be used to reduce visual impacts on the aesthetic integrity of the landscape.

  The facilities will be located within a ridgetop area that largely restricts visual and other aesthetic impacts to the immediate area. The cleared portions of the process area, where ridges will be leveled, will be kept at a minimum.

  The processed shale disposal area will be located within Southam Canyon to avoid extensive piling of processed shale, which would be inconsistent with the landscape.
- Disturbed land area will be kept to a minimum. Only those areas required for mining, storage, processing, and disposal operations or those areas

under revegetation will be disturbed. Employee travel outside the construction site or away from roads will be discouraged.

- The finished processed shale disposal surface will be contoured by creating shallow basins and hills resembling the natural terrain (see Section 3.10, Figure 3.10-6). The processed shale site is Southam Canyon; its visibility will be confined to the nearby area. The surface of the pile will be revegetated, as described in Section 4.6. It is anticipated that eventually the entire surface will be covered by native flora.

- All transportation activities will be restricted to the established corridors to prevent unnecessary additional disturbances to the landscape. The existing access road will be modified and will serve as a primary travel route. The new access road will conform to existing landforms as much as practicable. Revegetation of the pipeline corridors will reestablish the natural terrain.

- The retort facilities and other plant facilities will be located so that, with the exception of stacks and headframes, they will not be visible from viewpoints outside the immediate ridge areas (e.g., from the White River). Natural colors will minimize the visual contrast of these facilities with the landscape. Subordination of the facilities to the surrounding environment will be maintained as much as possible by location of components within natural slopes and valley areas.

  The landscape's slopes have a natural screening capacity, which allows some absorption of land alteration without excessive loss of visual character.

- Signs will be designed and constructed to be rustic and conform to BLM sign standards.

Section 4.10

Section 4.10

FIRE PREVENTION AND CONTROL

The fire prevention and control plan is described in Subsection 3.13.6 in Part 3 of this Detailed Development Plan.

Section 4.11

Section 4.11

OIL AND HAZARDOUS MATERIALS SPILL CONTINGENCY PLAN

4.11.1 INTRODUCTION

This section presents the general elements of an oil and hazardous materials spill contingency plan. The site-specific spill contingency operating procedure will be developed and implemented prior to startup of the facilities. The entire facility will be engineered and constructed to minimize the likelihood of emergency situations.

For the purposes of this section, spills fall into two categories:

- Normal Process and Tank Farm Area Spills. Those that occur as an unavoidable result of normal oil processing and tank farm operations, which lend themselves to easy control and cleanup through normal operation and maintenance practices.
- Transportation-Related Spills. Those that occur outside of the process and tank farm areas, whose detection, confinement, and cleanup require designation of men and materials to prevent pollution of land and waterways in areas not dedicated to and designed for oil processing.

4.11.2 NORMAL PROCESS AND TANK FARM AREA SPILLS

4.11.2.1 Prevention Procedures

All operating systems will be fully tested for mechanical integrity prior to initial startup. All pressurized systems will be tested at or above maxiumum operating pressures depending on the applicable code. Equipment will be tested to determine whether it will meet required ratings, etc. Operating manuals that detail procedures for plant operations, including emergency procedures, will be used to train and assist operators.

Process control through extensive instrumentation and appropriate computerized and manual controls will prevent or minimize spills due to process upsets. Regular maintenance programs will check the integrity of operating systems, and repairs will be made wherever necessary. Pumps, exchangers, and piping will be designed will provisions for draining of liquids to the oily water system before being opened up for maintenance or repair.

4.11.2.2 Detection Procedures

Process Area. Process control instrumentation will indicate leaks or malfunctions in all critical process streams. Central control room panels and local panels will give warnings of any upset condition. Vessels containing liquid hydrocarbons will have level indicators with high-level alarms. Hydrocarbon vapor detectors will be strategically placed. Waste streams and cooling water streams will be continually monitored for product or equipment malfunctions.

Tankage. Level sensors alarms will warn of improper operation and imminent spills or overflows. Regular and frequent visual checks will be made of tankage areas, and repairs will be made as necessary. Vapor detectors can be located in the low area around butane spheres or around other storage where leaks would generate heavy vapors.

4.11.2.3 Confinement

Process Area. In general, all process areas subject to spills will be paved with suitable impervious material and shaped to prevent spills from spreading over a large area. The amount of stored hazardous materials in a process area will be limited. Concentrated acids and caustics will be either curbed or placed so that any spills or leaks are confined to the immediate storage area. Spent or contaminated acids or caustics will be collected in special drain systems and recovered for reuse or neutralized before discharge to the sewer system.

Liquid overflows will be connected to the oily water sewers or to recovery or neutralization systems. Gases will be gathered in the relief and blowdown system, which will contain liquid separation systems for recovery of liquids.

Tankage. Details of confinement dikes and dams are given in Subsection 4.4.3.3. The holding basin will be sufficient to contain a volume in excess of that equal to the combined storage volume of the tankage in use during Phase II operations. Additional dikes will be built to provide more containment volume for Phase III operations.

4.11.2.4 Cleanup

Process Area. All areas subject to spills of hydrocarbons will normally be paved with concrete. Utility water and low-pressure steam will be provided throughout the process areas and will be used to wash down spills into the oily water sewer system and for general cleanup. Caustic or acid storage spills will be contained by curbing. The spilled caustics or acids will be recovered or discharged to the sewer system after neutralization.

Tankage. Drainage from diked areas will be manually controlled and will normally be sealed off. This will allow recovery of stored product when substantial amounts are spilled. Minor spills will be soaked up with suitable sorbents, and the surfaces will be cleaned. If the spills are on soil and a fire hazard is created, the soil will be removed. Minor amounts of oil may be washed into the holding basin. The oil will then be skimmed and stored in the slop oil tank.

4.11.2.5 Disposal

All minor hydrocarbon spills will be washed into the oily water sewer. The hydrocarbons will be recovered in the waste treatment plant and sent to the slop oil storage. The treated wastewater will be reused for dust

control and processed shale wetting. Contaminated sorbents and soil will be disposed of with processed shale.

4.11.3 TRANSPORTATION-RELATED SPILLS

Accidents related to transport of oil and/or hazardous materials on roads or to transport of oil by pipeline would be the likely cause of this type of spill. The following procedures will be used if a transportation-related spill occurs. In addition, prior to installation and use of a pipeline to transport oil produced in the commercial operation phase, the Spill Contingency Plan will be revised to include specific plans to cope with pipeline spills or leaks.

4.11.3.1 Prevention Procedures

The prevention of spills of oil and hazardous materials is a primary objective of White River Shale Project. The key to prevention is the establishment of an awareness of spill potential among the White River Project and contractor personnel through personnel education.

There will be orientation sessions for all project supervisory personnel, using films and literature supplied by equipment manufacturers, the federal government, and the American Petroleum Institute. White River Shale Project management will set up and conduct training sessions and will maintain records of the sessions and of personnel thus trained. In addition, review sessions will be organized periodically to keep the training program current and to ensure that proper instructions are given to employees who may be either new to the job or transferred from other assignments where oil spill contingency training was not given.

Adequate roads and maneuvering areas will be provided on tract to minimize spills due to collisions. Refueling of construction equipment will take place away from water courses; the equipment will have nozzles with a positive shutoff to avoid spillage from over-filling. Strict fire

prevention measures will be observed during refueling. Vehicle maintenance will be performed in designated areas only.

4.11.3.2. Action Procedure

A White River Shale Project or contractor employee at the scene of the operation who first learns about a spill will observe whether or not:

- Any human life or property is in danger
- The spill can be readily stopped or controlled

If human life or property is in danger, the employee will take prompt action to alleviate the danger. If the spill can be stopped or brought under control readily, the employee will do so and then notify his supervisor as soon as possible. If there is any doubt as to whether an incident constitutes a reportable spill, the employee will initiate the action procedure.

When the cognizant supervisor has been notified that a spill has occurred, he will:

- Determine that mobilization is underway to contain the spill
- Arrange for and dispatch additional personnel, material, and equipment as needed
- Set up communications relative to the emergency
- Ensure that the spilled material is recovered and properly disposed
- Notify the Area Oil Shale Supervisor and other appropriate federal and state agency personnel
- Gather information for the spill report
- Ensure that the spill area is properly cleaned

The following information will be gathered and confirmed by the cognizant supervisor as soon as possible:

- Date and time spill occurred or was first observed
- The original and present location of the spill

- Estimate of amount spilled and type of substance
- Environmental conditions: temperature, wind direction and speed, rain, snow
- If the spill is from a vehicle, the type, registration, owner, and operator of the vehicle
- Description of area likely to be affected, such as roadway, ditch, hillside, drainage
- Cause of spill, if determined
- Action taken to combat spill
- Agencies or persons notified

The senior White River Shale Project representative on tract will determine that all White River Shale Project facilities are available, as needed, for use in the spill emergency. He will be responsible for giving immediate notice of any spills or discharges of oil or other hazardous substances to the Area Oil Shale Supervisor and other federal and state officials.

Cleanup Procedure. Spills that occur on land will be cleaned up by recovering the pooled substance and removing the affected soil, if the soil is pervious, or by absorbing the substance, if the soil is impervious. Soils removed because they were contaminated with spilled matter will be buried in the processed shale pile where groundwater or surface water is less likely to become contaminated.

The likelihood that accidentally spilled oil or hazardous material will reach navigable waters is remote because the access road will pass through only one drainage that has a perennial watercourse (Evacuation Creek). Response to a spill in this area will be aimed at confining the spilled substance before it reaches the watercourse.

In the event that it is not possible to confine the spilled substance before it reaches the watercourse, equipment and materials specifically designed and previously successfully used for recovering spilled substance will be

readily available. This equipment and material, consisting of a containment boom, pumps, hoses, valves shimmer, small boat and motor, absorbant material and miscellaneous hand tools, will be kept in a protected predesignated location suitably marked and available for use to all personnel. This equipment for spill contingencies will not be used for other purposes.

In addition to the above, trucks, graders, loaders, vacuum tanks, and other related mechanical equipment will be available for use in the containment and cleanup of any spilled substance.

Materials specifically designated for use only on spill cleanup will be stored in a well-marked location known and accessible to all personnel. Materials will be adequately marked for identification, protected from the elements, and not used for other purposes.

4.11.3.3 After-Spill Procedure

When a spill has been contained and cleaned up, the cognizant supervisor will make sure that all usable materials employed in the operation are cleaned and checked for serviceability. Materials specifically designated for spill containment and cleanup will be returned to the original storage area. Consumables and damaged items will be restocked to maintain minimum levels of listed spill contingency equipment.

An environmental assessment of the area affected by the spill will be conducted. A report will be sent to the Area Oil Shale Supervisor, and this report will describe:

- Area affected by the spill
- Extent of damage, if any, to the flora and fauna
- Proposed remedial measures

Section 4.12

Section 4.12

PREVENTION OF HAZARDS TO PUBLIC HEALTH AND SAFETY

Safety responsibilities and precautionary approaches for avoiding hazards to public health are primary considerations in the White River Shale Project. Air and noise pollution safeguards are discussed in Section 4.2. General safety controls for employees of the project and contractors are covered in Sections 3.5 and 3.13. Antitoxic and precautionary measures against hazardous materials are explored in Section 4.11. This section and Table 4.12-1 identify possible public hazards and protection measures. For further discussion on safety after decommissioning, refer to Section 5.8.

4.12.1 ENVIRONMENTAL REGULATIONS

Section 5 of the Oil Shale Lease Environmental Stipulation (E.S.) requires that all necessary measures be taken to protect the health and safety of persons affected by White River Shale Project activities. All public accesses to hazardous areas will be controlled (E.S. Section 2) and, should it be necessary, may remain controlled.

Sections III-84 and 88 of the Code of Waste Disposal contain provisions requiring isolation of sanitary waste stabilization ponds. Although these requirements do not specifically apply to the impoundments planned for WRSP, Section III-91 "Industrial Waste Ponds" states that ponds receiving industrial wastewater (containing no domestic wastewater) are subject to design requirements determined by engineering analysis and other sources. On this basis, Utah Code Section III-84 "Isolation" is assumed to apply to access control of all impoundments planned for WRSP. This section stipulates that ponds will be enclosed with a fence

adequate to exclude small animals, livestock, and people, and that locked access gates must be provided. Signs that describe the nature of the facility and advise against trespassing will be posted.

4.12.2 MINE PORTALS AND SHAFTS

All mine portals and vent shafts will be fenced and posted to warn trespassers. When the mine is abandoned and no further exploration is planned, all mine shafts and portals will be sealed and rehabilitated as discussed in Section 5.6.

4.12.3 PROCESS AREA AND TANK FARM

In accordance with Utah Code specifications, fences and placards to warn trespassers will be erected around the process areas for each phase of the WRSP as soon as construction begins. Entrances to the plant will be checked by guards located on all access roads.

During abandonment, all process equipment will be dismantled and removed, all cavities filled over, and sharp protrusions such as reinforcing bar eliminated. Concrete pads and subsurface structures will be left in place, and should not present any danger to the public.

4.12.4 PLANT ACCESS ROADS

Speed limits and caution signs will be posted on the plant access roads, and warning signs will be erected at the tract boundaries and entrance trails. The dirt road that passes from east to west across Southam Canyon will be either closed or rerouted around the processed shale disposal area.

4.12.5 PROCESSED SHALE DISPOSAL

Processed shale conveyors, trucks, and other heavy equipment may pose hazards to the general public. To minimize such hazards, all public access to the plant will be prohibited for the duration of the White River Shale Project.

4.12.6 WATER AND WASTEWATER IMPOUNDMENTS

The freshwater reservoir will store uncontaminated water. Catchments downstream and upstream from the processed shale deposit will contain contaminated water during the life of the project, but this water will be used in various activities. The wastewater holding basin and the emergency storm basin will also contain contaminated wastewater from the process area. Impoundments filled with contaminated water not already located within the larger enclosures will be individually fenced and placarded with cautionary warnings.

After abandonment, all impoundments will be emptied with the exception of Southam Canyon retention dam, which will remain operational. The retention dam will remain fenced and placarded. Dam structures for all other impounds will remain enclosed and placarded. For further discussion, refer to Section 5.8.

4.12.7 PRODUCT AND FRESHWATER PIPELINES

No public health hazards are expected to develop from either the product or freshwater pipelines since they will be underground. Signs will be posted along each route warning against excavation.

Freshwater pumping facilities constructed near the bank of the White River during Phase II will be fenced and posted.

4.12.8 CONSTRUCTION ACTIVITIES

Construction activities such as earth moving, blasting, sinking shafts, grading, installation of equipment, and other related work will necessitate precautionary methods which, among other things, will prohibit public access into the construction zone.

4.12.9 CARCINOGENS

White River Shale Project is aware of the concern that potential carcinogenic hazards may arise from the production of shale oil. Today, however, there is no definitive scientific proof connecting oil shale mining or its processing to abnormal incidence of human cancer. Most recent comments in the press have referred to the preliminary results of current studies conducted by scientists at the Denver Research Institute under the sponsorship of the National Science Foundation. These results have shown that samples of processed shale chemically tested contained, among other things, significant levels of benzo(a)pyrene (BaP), a type of polycondensed aromatic hydrocarbon known to be a carcinogen. It is common scientific knowledge that the presence of BaP, as determined by chemical analysis, does not establish the carcinogenic potency of a material. Extensive tests must be run before this potential can even be considered a hazard.

White River Shale Project is aware of the growing research effort by governmental agencies and research institutes directed at the prevention of cancer. The owners of White River Shale Project are actively participating in a study being conducted by the American Petroleum Institute. Among other organizations known to be doing work on carcinogens before they are introduced into the environment are the Environmental Protection Agency, the Energy Research and Development Administration, the Department of Health, Education and Welfare, the National Cancer Institute, and the National Institute of Occupational Safety and Health. The results of these research efforts will be watched carefully, and all necessary steps will be taken to prevent or minimize the hazards as soon as evidence of the hazard is recognized.

Meanwhile, precautionary steps to safeguard the health of the public and the employees of White River Shale Project are being included in the plans of the White River Shale Project.

Table 4.12-1

SUMMARY OF PUBLIC HEALTH AND SAFETY MEASURES

Type of Activity	Construction Phase of Each Activity			Operation Phase of Each Activity	
	Construction Schedule	Hazards	Protective Measures	Hazards	Protective Measures
Mine Portals and Shafts					
Phase II	Before Phase II	Blasting, material and equipment movement	Access road control with flagman and signs, plus additional signs around blasting area (accepted safety practice when blasting)	Mine shafts and equipment movement in and out of mine	Entire process area, stockpile, and mine area is fenced and placarded with warnings
Phase III shafts (U-b incline)	Before Phase III	Same as above	Same as above	Mine entrance and mine shafts, and equipment movement	Mine entrance is within fenced process area. Vents outside process area will be covered, fenced and placarded
Phase IV mine shafts (U-a incline)	Before Phase IV	Same as above	Same as above	Same as above	Same as above
Process Area and Tankages					
Phase II	Before Phase II	Blasting, grading, and hauling equipment, etc.	Access road control with warning signs and flagman. Area to be fenced as soon as possible	Process equipment, mass material movement, flammable hydrocarbon storage, etc.	Process area and mining activities will be fenced and placarded, and access road entrance controlled
Phase III and IV	Before Phase II	Same as above	Same as above	Same as above	Process area, tank farm, and mine adits are fenced and placarded. Gate is guarded and access road placarded
Access Road and Other Passages					
Access road	Before Phase II	Same as above	Flagman and placarding at Utah 45 crossing, placarding on dirt road to south of construction. Entrance prohibited to public	Heavy truck and equipment traffic during Phases II, III, and IV	Frequent speed limit signs and caution signs, and restriction of access to process areas

Type of Activity	Construction Phase of Each Activity			Operation Phase of Each Activity	
	Construction Schedule	Hazards	Protective Measures	Hazards	Protective Measures
Other passages through or into the tracts	Before Phase II, III, and IV	No improvements planned. Road crossing in Southam Canyon may be hazardous during processed shale disposal operations	Placarding all roads entering tract	Occasional traffic of heavy trucks and other equipment	Reroute or close the road crossing Southam Canyon when processed shale disposal operations approach it
Processed Shale Disposal					
Phase II	Before Phase II	Conveyors, trucks, and construction equipment movement	No road approaches this area. Placarding restricting access to fill area and conveyor truck routes	Conveyor, trucks, and equipment movement at fill site	No road approaches this area. Placarding along routes and fill area restricting access
Phases II, III, and IV	Before Phase III	Construction blasting, grading, and equipment movement for conveyor pathway	No existing roads pass over conveyor route. Placarding and blasting safety procedures as above	Conveyor operations, truck, stacker, and equipment movement in Southam Canyon	Reroute or close road crossing Southam Canyon as above. Restrict and placard all other possible entries to canyon
Impoundments					
Freshwater reservoir	Before Phase III	Construction equipment and material movement for dam	Flagman on improved access road and placarding around site	No water quality hazard. Trespassing on dam may be hazardous.	Placarding to discourage trespassing and swimming. Fencing of dam to prohibit trespassing
Impoundments south of processed shale disposal fill	During Phase IV	Hazards same as for processed shale disposal	Provisions same as for processed shale disposal	Water may be contaminated by contact with processed shale	Placarding to discourage trespassing and swimming

Type of Activity	Construction Phase of Each Activity			Operation Phase of Each Activity	
	Construction Schedule	Hazards	Protective Measures	Hazards	Protective Measures
Phase II catchment	Before Phase II	Same as freshwater reservoir	Same as freshwater reservoir	Water contaminated by contact with processed shale. Trespassing on dam dangerous	Pool and dam fenced and placarded
Southam Canyon retention dam	Before Phase III	Same as above	Same as above	Same as above	Same as above
Wastewater holding and storm runoff basin	Before Phase II	Same as above	Same as above	Contaminated water contact and trespassing on dams hazardous	Dam and pool contained in process area fenced. No other procedures required
Product and Freshwater Pipelines					
Freshwater pipeline	Before Phase II	Heavy equipment movement and some blasting	No new placarding required except over buried pipe warning against excavation	No hazard during operations since buried. Pumping stations may be hazardous to trespassers	Pumping house placarded and fenced. Signs over pipeline maintained
Product pipeline	Phase III	Same as above	Same as above	Slight hazard during operations if pipe ruptures	Placards over pipeline maintained

PART 5

Section 5.1

Section 5.1

INTRODUCTION

Part 5 presents a discussion of the potential project impacts on each of the six environmental resources — water, air, biological, soils and geology, historic and scientific, and aesthetic — and briefly touches on the environmental effects of decommissioning and abandonment. The analyses are predicated on the implementation and normal operation of all pollution control systems and environmental protection plans proposed in the DDP to conform with the applicable federal, state, and local statutes and the lease requirements. The impact analyses reflect the current estimates of the most probable case. In several instances, worst case conditions have been assumed to demonstrate that the predicted impacts can be dealt with satisfactorily.

Section 5.2

Section 5.2

EFFECTS ON AIR RESOURCES

Construction and operation of the proposed White River Shale Project will affect the atmospheric environment at each development stage. However, these effects will be kept small or negligible by implementing a comprehensive emission control program and by burning treated and cleaned fuels.

The following methods were used to assess potential impact of the project on the air resources:

- On the basis of best available information, estimates were made of all potential emissions during various phases of the project. These estimated emissions are tabulated in Tables 4.2-5 and 4.2-6 in Section 4.2. The expected emissions from Phase III are not listed; they will be approximately one-half of those from Phase IV.
- Estimates of process stack heights, exit gas temperatures, and stack velocities are also included in the emission inventories in Section 4.2.
- Short-term ground level pollutant concentrations were calculated using the Environmental Protection Agency's (EPA) "PTMTP" computer program and were adjusted from 15-minute results to the appropriate averaging time using Larson's factors (Ref. 49).
- Long-term (annual average) ground level pollutant concentrations were calculated using the EPA's "Terrain" computer model.

The results of the effects analyzed are discussed in the following subsections.

5.2.1 CONSTRUCTION PHASES

5.2.1.1 Construction of Phase II

As shown in the schedule of facility development (Section 3.19), construction of the Phase II plant is expected to last 3 years. During that time, the main source of air pollution will be fugitive dust* produced by earth-moving equipment and heavy traffic on unpaved soil.

Construction will proceed simultaneously in several areas — process area, water pump station, water pipeline, access road, and catchment dam — but activity at the process area will be the most intensive and concentrated and is expected to produce the most dust. Based on 1.4 tons of fugitive dust per acre-month (EPA data) and 50 acres as the maximum construction area, the peak construction activity on the process area could produce up to 4,700 pounds of fugitive dust per day.

The planned program of wet suppression will reduce this amount of dust by 75 percent to 1,175 pounds per day. This amount of dust, distributed over an area source of 750 by 1,350 meters, will result in a maximum 24-hour average downwind concentration of approximately 60 micrograms per cubic meter (150 including background) in the first kilometer downwind under worst case meteorological conditions, and in 12 micrograms per cubic meter (28 including background) under average conditions. These calculations were made using the method cited by Turner (Ref. 50) for area sources. Assumed were:

- An area width of 750 meters
- A 12-hour work day

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*Fugitive dust is defined as colloidal-sized particulate matter generated incidentally by man's activities. Particulates, on the other hand, refer to solid materials generated by processes and emitted from a discrete source.

- "Worst case" and "average case" meteorological scenarios:
  - Worst Case: 8 hours of neutral (D) stability with a 2.5-meter-per-second wind speed and 4 hours of stable (E) conditions with a 1-meter-per-second wind speed
  - Average Case: 6 hours of unstable (B) conditions with a 2-meter-per-second wind speed and 6 hours of neutral (D) stability with a 4-meter-per-second wind speed

It is clear that the national secondary standard for particulates of 150 micrograms per cubic meter for 24 hours will not be exceeded except possibly under infrequent worse-case meteorological conditions.

The frequency with which worst case atmospheric conditions occur simultaneously with heaviest construction activities will probably be quite low (only a few times a year), and the impacts are expected to be negligible.

The construction-generated fugitive dust may have two minor effects on local meteorology. First, the smallest dust particles may become airborne and act as condensation nuclei to cause a minor increase in local precipitation. Because the region is semiarid, any precipitation increase that develops might be beneficial, but any changes might be very small. The second effect may be occasional reduction in visibility in the immediate vicinity of the construction activities, but this condition is not expected to be significant except in the vicinity of the dust source.

5.2.1.2 Construction of Phases III and IV

The construction of the commercial Plant is expected to last 4 years, and most of the earthwork will be done during the early state. On the basis of current estimates of the maximum possible excavated area, up

to 11,200 pounds per day of fugitive dust could be produced during the initial earthwork period. The planned dust control program of wet suppression will reduce this amount by 75 percent to 2,800 pounds per day.

The maximum downwind 24-hour concentration of fugitive dust, assuming an area source of 1,000 by 1,500 meters and using worst case meteorology, would be 137 micrograms per cubic meter in the first kilometer downwind and 24 micrograms per cubic meter using average meteorology. As is true for Phase II construction, no ambient air standards would be exceeded, and impacts would be negligible.

As discussed above, effects of construction-generated fugitive dust on local meteorology are expected to be minor: possible increase in local precipitation and visibility reduction in the immediate area.

5.2.2 PHASE II OPERATION

During Phase II of the White River Shale Project, when only a single retort will be operated, overall plant emissions, listed in Table 4.2-5 of Section 4.2, will be only a fraction of those expected during Phase IV. Because Phase IV operation will meet regulations (see Subsection 5.2.4) and because ground level concentrations are proportional to emissions, it is expected that during Phase II all regulatory requirements will be met with adequate margins. Therefore, no analyses of effects are presented in this section.

5.2.3 PHASE III OPERATION

In Phase III of the project, emissions from all sources will be approximately one-half of those from full-scale (Phase IV) operation, as detailed in Table 4.2-6, Section 4.2. Since downwind concentrations are

proportional to emission levels, it is expected that concentrations and subsequent effects will be only about one-half of those resulting from full-scale operation, as described in Subsection 5.2.4.

5.2.4 PHASE IV OPERATION

Maximum effects of air pollutants on the environment will occur when the proposed project is in full-scale (Phase IV) operation, when 160,000 tons per day of raw shale will be handled and processed to produce 100,000 barrels per day of raw shale oil. During full-scale operation, a significant quantity of pollutants — particulates, fugitive dust, sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons — will be produced by the various mining and processing activities. These sources and the resulting polutants are described in Table 4.2-6, Section 4.2. To abate air pollutants and to minimize their effects on the environment, a number of control measures and devices will be incorporated into the project plan. These controls are also noted in Table 4.2-6 and are discussed more fully in Subsection 4.2.3.

Because of the complexity of the sources (up to 45 individual source points, with varying stack heights), the computation of resulting downwind pollutant concentrations could be performed only by digital computer methods. Two methods were selected. Inputs to the model included onsite meteorological data collected in 1975 and formulated into a joint frequency of wind speed, direction, and stability distribution.

In any application of computer models, it is important to note that results produced are, at best, approximations. All dispersion models in use at present have been developed to simulate complicated and interactive atmospheric phenomena that are not yet completely understood or are so complicated as to be beyond computer capabilities. Consequently, such simulations become a bit simplistic.

5.2.4.1 The EPA "PTMTP" Computer Model

The short-term maximum concentrations were calculated with EPA's "PTMTP" Model. The model was used to compute, at multiple receptor points, short-term pollutant concentrations resulting from multiple-point sources. The results were then modified from short averaging times (10 minutes) to the appropriate time period (up to 24 hours) using Larson's methods (Ref. 49). It should be noted that this adjustment factor is not directly applicable to the White River tracts, but it is probably a reasonable estimate. The "PTMTP" Model was run for a range of wind speeds and atmospheric stability catagories (see Ref. 50) to determine the point of maximum concentration of each pollutant of interest. Because the relief of the plant site and surrounding region is rugged, terrain elevations were incorporated into the model. In all cases, for each downwind distance, maximum terrain height at that distance in any receptor sector was used to represent the height of the entire sector. This produced conservative results.

5.2.4.2 The EPA C9M3D "Terrain" Model

Long-term (1-year, annual average) concentrations were calculated using the EPA C9M3D "Terrain" Model. This model was chosen because it can incorporate terrain effects (such as those found on the leased land) on concentrations. It should be noted, however, that the results obtained with C9M3D have not been validated by comparison with actual long-range data. This model makes use of a data file that contains the annual joint frequency of wind speed, wind direction, and atmospheric stability and accepts up to 50 point or area sources to calculate annual average concentrations at seven downwind receptor distances around the compass. The model can also be used with terrain features incorporated, in which case the maximum terrain in each directional sector is used to characterize the sector. This results in conservative (high) estimates.

5.2.4.3 Results of Short-Term Analyses

The results of the short-term analyses are shown in Table 5.2-1. The concentrations shown are those produced from "PTMTP" Model for a spectrum of wind speeds and all atmospheric stabilities. Maximum terrain elevation for each distance (independent of direction) was used as a conservative approach. Because of differing geometries of source terms for each pollutant (different emissions come from each process), the maxima occur at different downwind distances.

Table 5.2-1 shows that, with the exception of particulates and hydrocarbons, all short-term ambient air quality standards are met by large margins. The estimated hydrocarbon concentration value of 282 micrograms per cubic meter (which includes methane) exceeds the primary standard, but the source of hydrocarbons, particularly the fines-type retort preheaters, emit an unknown quantity of methane that is excluded from the regulatory limit. One reference (Ref. 51) indicates that as much as 80 percent of the hydrocarbons in off gases may be methane. If this is true of the White River Project hydrocarbon emissions, the downwind maximum hydrocarbon concentration contributed by the plant may be as low as 11.8 micrograms per cubic meter of nonmethane hydrocarbons.

It is of further interest to note (see Subsection 2.4.3) that the hydrocarbon standard is now occasionally exceeded on the proposed site, although there are no apparent hydrocarbon sources present other than the oil shale and natural vegetation. Since background nonmethane hydrocarbon levels are frequently quite high, e.g. 100 to 150 micrograms per cubic meter, the levels occurring with additional plant emissions are quite likely to exceed ambient air standards.

Using worst case meteorological conditions and assuming that wind persists for 24 hours along the axis between the center of the shale disposal area and the plant center, the maximum value of all particulates (including fugitive dust, particulates from all point sources, and

maximum background concentration) is 257 micrograms per cubic meter. This value exceeds the national secondary 24-hour particulate standard of 150 micrograms per cubic meter, and closely approaches the primary standard of 260 micrograms per cubic meter. However, this situation is expected to occur only in specific circumstances that probably occur much less frequently than once a year. In addition, the predicted high value would occur approximately 1,000 meters east of the plant center, a location well within the lease boundaries. More typically, the average particulate concentration, including background, would be approximately 50 micrograms per cubic meter at this distance.

5.2.4.4 Results of Long-Term Analysis

The results of the long-term annual average concentration analyses are shown in Table 5.2-2. This table shows the maximum annual average concentration for each of the three pollutants (particulates, sulfur dioxide, and nitrogen oxides) for which there are annual standards, and the direction and distance at which the maxima are predicted to occur. The results shown were summarized from the results produced by the EPA C9M3D "Terrain" Model. To be conservative, the maximum terrain elevation in each receptor sector was used to represent the sector terrain height. Because of differences in the geometries of source terms, points of maximum annual average concentrations appear in different directions and at different distances. Table 5.2-2 shows that all annual regulatory limits are met. The particulate maximum annual average concentration, including fugitive dust, reaches only a fraction of the primary standard, and should not be a problem, particularly off site. Other pollutant levels are well below the regulatory limits. Figures 5.2-1, 5.2-2, and 5.2-3 show the distribution of average annual pollutant concentrations of particulates, sulfur dioxide, and nitrogen oxides, respectively, around the plant site to a distance of 12 kilometers (6.5 miles). Areas of maximum concentrations are shown in these figures.

Table 5.2-1

SHORT-TERM MAXIMUM
EXPECTED CONCENTRATIONS[a]

Pollutant	Plant-Contributed Concentration[b] ($\mu g/m^3$)	Distance[c] (m)	Stability[d]	Wind Speed (M/sec)	Recorded Maximum Background[e] ($\mu g/m^3$)	Plant Max Plus Background Max ($\mu g/m^3$)	Expected Typical Concentrations ($\mu g/m^3$)	Reg. Limits
Particulates								260
(24-hour)	167[f]	1,000	Mixed[g]	–[g]	90	257[f]	51.4	150
Sulfur dioxide								
(24-hour)	21.9	1,100	Mixed[g]	–[g]	25	46.9	10.4	365
(3-hour)	116	5,000	F	2	25	156	14.6	1,300
Hydrocarbons								
(3-hour)	58.9[h]	2,00	F	1	480[i]	538.9	21.9	160[j]
Carbon monoxide								
(8-hour)	133.8	2,000	E	1	900	1,033.8	391.7	10,000
(1-hour)	73.6	2,000	E	1	1,800	1,873.6	204.9	40,000

(a) Results are for worst case meteorology (see also typical values)

(b) Includes fugitive dust for particulates

(c) Distance from plant center

(d) Defined by Pasquill-Turner

(e) Based on onsite data

(f) Occurs only when disposal area and plant area are aligned along wind direction axis; joint probability of wind alignment, constant wind direction, and worst case meteorology occurring for 24 consecutive hours is much less than once a year

(g) 6 hr "C," 3 m/s; 6 hr "D," 3 m/s; 12 hr "E," 1 m/s; constant wind direction assumed

(h) Includes methane, unknown amount

(i) Excludes methane

(j) Excludes methane; 6-9 a.m. only

Table 5.2-2

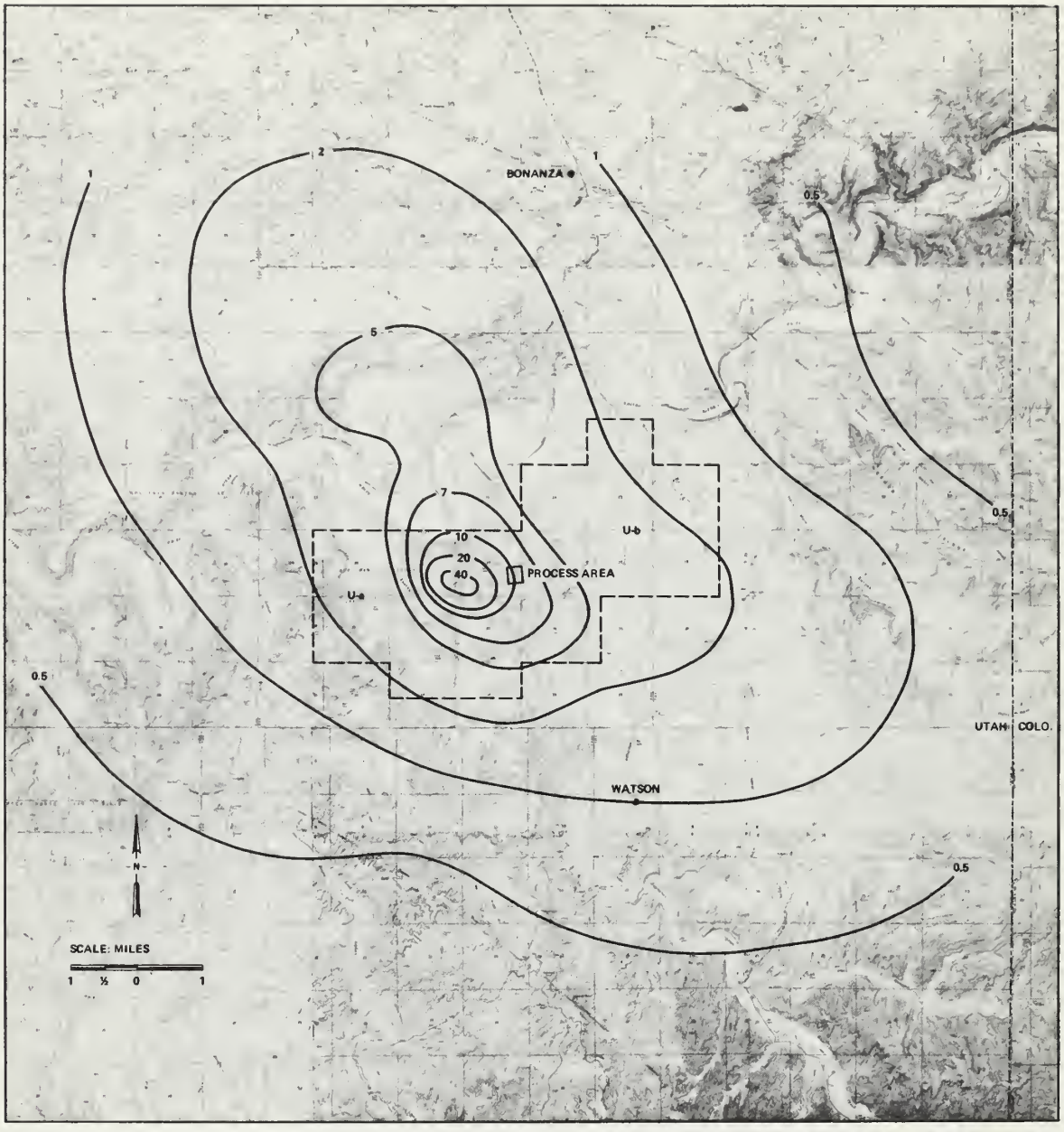
MAXIMUM AVERAGE EXPECTED CONCENTRATIONS

Pollutant	Plant-Contributed Concentration ($\mu g/m^3$)	Distance and Direction From Plant Center (m)	Plant Plus Back-Ground Concentration ($\mu g/m^3$)	Federal and State Regulatory Limit
Particulate	39.3	1,000-W	55.0	75 $\mu g/m^3$ primary 60 $\mu g/m^3$ secondary
Sulfur dioxide	2.66	1,000-E	12.66	80 $\mu g/m^3$ primary
Nitrogen oxide	14.1	1,875-SW	19.93	100 $\mu g/m^3$ primary and secondary

5.2.5 SIGNIFICANT ON-TRACT AND OFF-TRACT IMPACTS

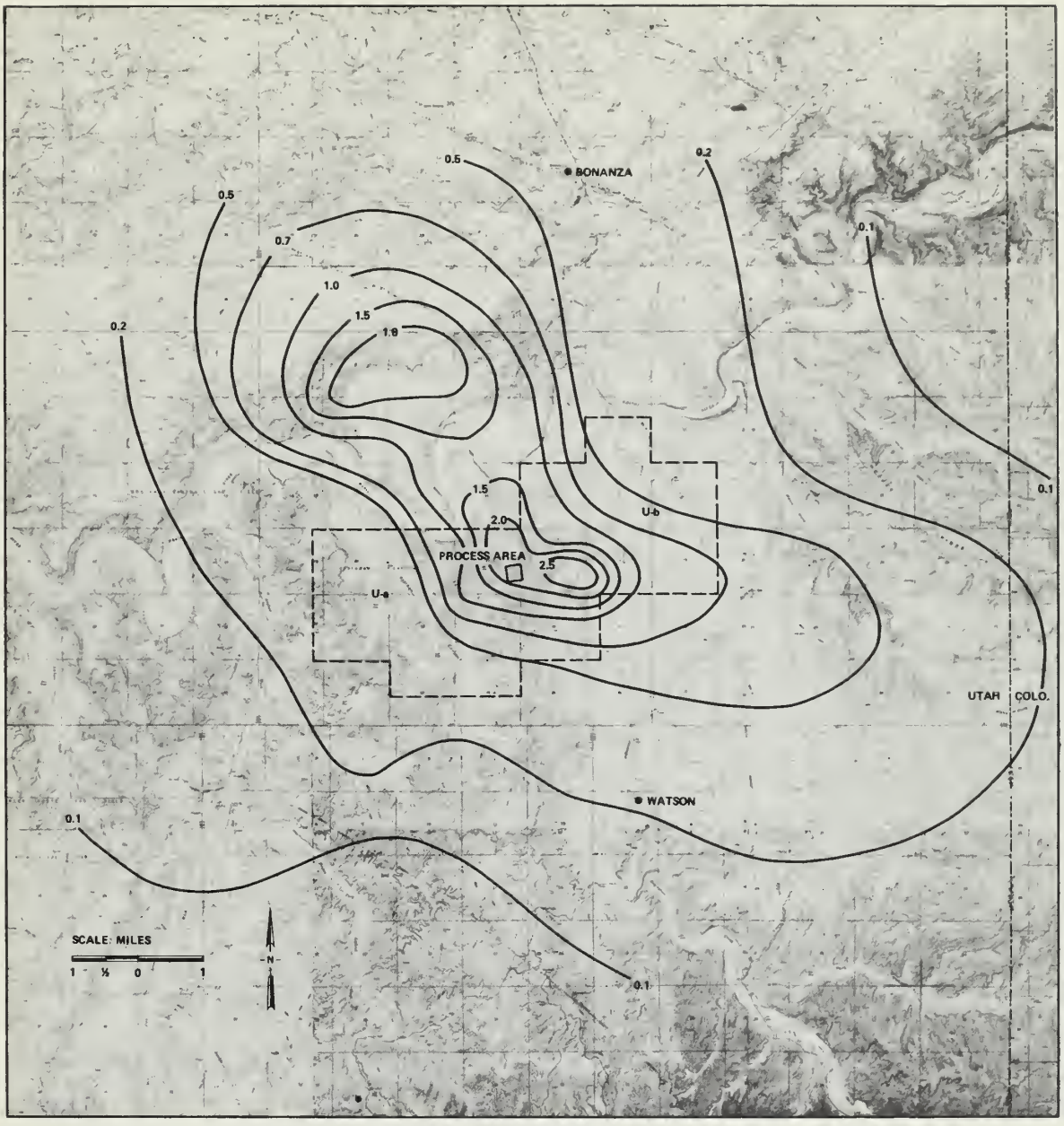
With the possible exception of hydrocarbon levels, which may occasionally exceed standards at certain on-tract locations, all emission and ambient air quality standards will be met during all phases of plant construction and operation. Both primary (protection of human health) and secondary (protection of plants and animals) ambient air quality standards will be achieved by reasonable margins. Based on the results of this analysis of potential effects of air pollutants on the environment, no significant on-tract or off-tract impacts are expected. There may be minor impacts, such as occasionally reduced visibility in the immediate vicinity of the plant site, a possible slight change in local precipitation, and occasional low fog that may form over the warm processed shale disposal pile.

Under present EPA regulations concerning significant deterioration, none of the sulfur dioxide increment limits for a Class II area will be exceeded. However, it is likely that both the 24-hour particulate increment limit for Class II (30 micrograms per cubic meter) and the annual limit (10 micrograms per cubic meter) would be exceeded occasionally.



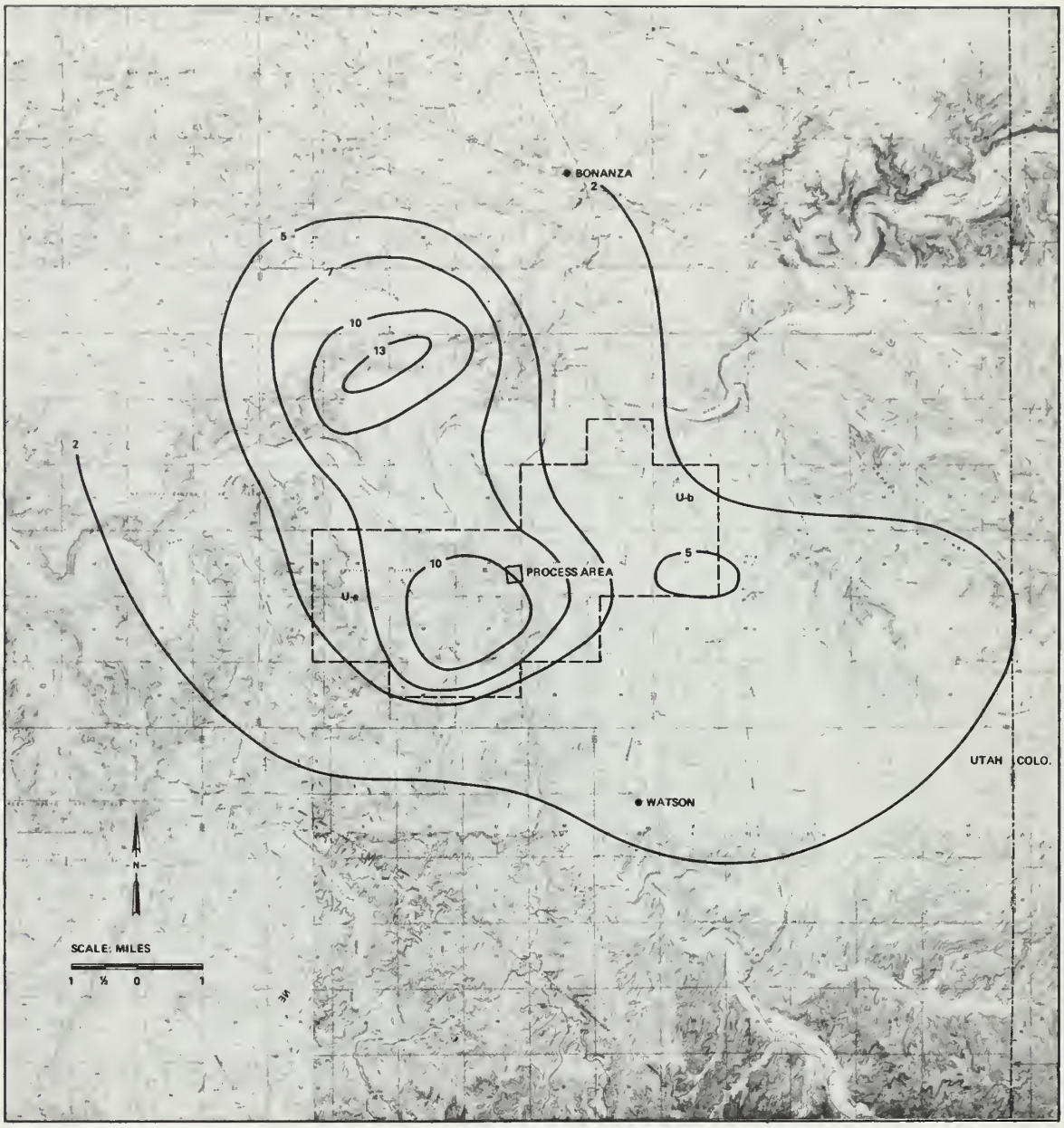
NOTES: 1. NATIONAL PRIMARY STANDARD = 75 MICROGRAMS PER CUBIC METER ANNUAL AVERAGE.
2. NATIONAL SECONDARY STANDARD = 60 MICROGRAMS PER CUBIC METER ANNUAL AVERAGE.
3. NATIONAL LIMITS OF SIGNIFICANT DETERIORATION (CLASS II) = 10 MICROGRAMS PER CUBIC METER ANNUAL AVERAGE INCREMENT.
4. VALUES SHOWN ARE IN MICROGRAMS PER CUBIC METER.
5. DEPICTED VALUES EXCLUDE ANNUAL AVERAGE BACKGROUND OF 15.7 MICROGRAMS PER CUBIC METER.

Figure 5.2-1. Annual Average Particulate Concentrations



NOTES: 1. NATIONAL PRIMARY STANDARD = 80 MICROGRAMS PER CUBIC METER ANNUAL AVERAGE
2. NATIONAL LIMITS OF SIGNIFICANT DETERIORATION (CLASS II) = 15 MICROGRAMS PER CUBIC METER ANNUAL AVERAGE INCREMENT
3. VALUES SHOWN ARE IN MICROGRAMS PER CUBIC METER.
4. DEPICTED VALUES EXCLUDE ANNUAL AVERAGE BACKGROUND OF 4.28 MICROGRAMS PER CUBIC METER.

Figure 5.2-2. Annual Average Sulfur Dioxide Concentrations



NOTES: 1. NATIONAL PRIMARY AND SECONDARY STANDARDS = 100 MICROGRAMS PER CUBIC METER ANNUAL AVERAGE.
2. VALUES SHOWN ARE IN MICROGRAMS PER CUBIC METER.
3. DEPICTED VALUES EXCLUDE ANNUAL AVERAGE BACKGROUND OF 5.83 MICROGRAMS PER CUBIC METER.

Figure 5.2-3. Annual Average Nitrogen Oxide Concentrations

These occurrences will be predominantly within the tract boundaries. Present state-of-the-art control techniques will reduce the quantities emitted to meet all ambient air standards, but will not allow complete compliance with current significant deterioration Class II standards. If the State of Utah reclassifies the lease tracts to Class III, the project could comply fully with all standards.

The computer models used to estimate pollutant concentrations are generally conceded to be accurate to a value of one-half to twice the computed value. To compensate for the expected limits of accuracy, a number of conservative assumptions were made that included summer-time midday temperatures for all hours of the day and night, and the use of the highest terrain in sectors to be representative of the area. These assumptions reduced effective plume rise and resulted in higher concentrations. Because of the conservative assumptions, it is probable that few higher concentrations than those computed for worst case situations will be measured. After the second-year baseline meteorological data collection is completed and field tests are run, the computer models can be validated for the project tracts.

5.2.6 NOISE IMPACTS

Noise is another type of air pollutant. The following paragraphs discuss noise as it will be encountered in construction and operation of Phases II, III, and IV and in off-tract situations.

5.2.6.1 Phases II Construction Noise

Noise caused by construction activities will depend on day-to-day schedules, variation in equipment operation, weather conditions, and other factors. Since these variables may change from time to time during the entire construction period, noise level estimates and impact evaluations for construction activities are based on expected maximum

or worst conditions. The noisiest activities during construction will be blasting, excavation, and grading of the site.

Since there are no residents within the tract area, the on-tract impact of construction noise will be limited to construction workers. An estimated 50 workers will be directly involved with the operation of earth-moving equipment, rock drills, and blasting activities. These personnel will be more exposed to high noise levels than others on the project.

The noise level inside the cabs of earth-moving equipment may be as high as 105 dBA, depending on the type, capacity, mode of operation, acoustical treatment, and other factors. The noise level of rock drills near the ears of the operators may exceed 100 dBA.

If the noise level is not controlled, exposure to these noise levels during a typical work shift may exceed the operational noise exposure limits specified in the federal and Utah occupational safety and health regulations as described in Section 4 of Environmental Regulations and Guidelines, (Ref. 46). The impact on personnel will be minimized by adhering closely to the regulations and employing feasible noise control procedures and techniques (see Subsection 4.2.4).

5.2.6.2 Phase II Operation Noise

On-tract noise impact throughout the project will be limited to personnel working close to machinery and equipment. The noise generated by mining, material handling, and processing is expected to be in excess of 90 dBA in certain areas. This will include many areas that are accessed only during occasional maintenance operations. Activities that can be expected to create high noise levels include mining, crushing and screening, shale loading, retorting, and upgrading. High noise exposure of workers will be limited by regulations and guidelines governing occupational noise exposures (see Section 4 of Ref. 46) and subsequent noise

control procedures and techniques specific to the facility operation (see Subsection 4.2.4).

5.2.6.3 Phase II Off-Tract Noise

Off-tract noise during Phase II will be generated by three major sources: the facility construction, the facility operation, and traffic to and from the facility.

Noise generated by the construction and operation of the facility itself will be attenuated by distance, atmospheric absorption, and bluffs and rough terrain acting as natural barriers, all of which will provide substantial acoustic isolation to nearby communities.

Traffic-generated noise will not be confined to the facility. The impact of traffic noise will depend on traffic volumes, the path of the facility's main access road, and the proximity to nearby communities.

The nearest community is Bonanza, approximately 5 miles away from the tract and separated from the facility by rough terrain. With currently planned construction schedules, the expected maximum excavation and blasting noise levels at Bonanza caused by the construction of the Phase II facilities are shown in Table 5.2-3. Only two blasts per day are expected. Noise attenuation by distance, atmospheric absorption, and terrain effects are included in the prediction of these noise levels, and it is also assumed that the blasting will be conducted by regulating the amount of explosives.

Table 5.2-3

PROJECTED MAXIMUM NOISE LEVELS AT BONANZA
CAUSED BY PHASE II CONSTRUCTION

Construction Activities	A-Weighted Sound Level (dBA)	Peak Sound Pressure Level (dB)	Peak Over-Pressure (lb/ft^2)
Excavation, earth moving, and grading of process area	40	–	–
Blasting of process area and mining and ventilation shafts	–	83	5.9×10^{-3}

The expected maximum noise levels are evaluated in terms of the U.S. Department of Housing and Urban Development (HUD) noise criteria and the EPA-proposed sonic boom criteria, as presented in Section 4 of Environmental Regulations and Guidelines (Ref. 46).

When the predicted A-weighted sound level shown in Table 5.2-3 is compared with HUD's criteria, the noise level at Bonanza during the noisiest stage of Phase II construction is estimated to fall within the HUD acceptable range. Similarly, when the peak overpressure of blasting noise is compared with EPA's proposed criteria, it is concluded that this noise is not likely to annoy the residents of Bonanza.

Because of the limited amount of equipment operating during Phase II, noise propagated off tract will not be substantial. Noise from facility operation is expected to be below the background noise levels of 25 to 30 dBA, which are typical of the area and the town of Bonanza (see Subsection 2.3.5).

The main route to and from the facility passes by the community of Bonanza. In predicting traffic noise, personnel access traffic is assumed to originate outside of the town of Bonanza and pass by it. In the event that all or most of the personnel traffic originates in Bonanza, community planning will be required to minimize the noise impact to the residents.

Traffic noise will be generated by employee car and truck traffic as well as by supply truck traffic. Employee traffic during both construction and operation will be limited mostly to shift changes and, possibly, lunch breaks. Supply truck traffic will be interspersed throughout the day.

The traffic noise is evaluated in terms of L_{50} (average level), or the noise level exceeded 50 percent of the time. This average level derived from the range of baseline data is estimated to be 30 dBA near the facility and Bonanza. The impact is based on an increase in L_{50} levels at the nearest residences in Bonanza, and the resulting levels are compared with HUD criteria.

Both construction and operation traffic noise levels fall well within the HUD acceptable range. Traffic noise during Phase II construction is expected to increase the ambient L_{50} levels to 38 to 43 dBA.

Traffic noise during Phase II operation is expected to decrease because of reduced traffic volumes. The reduced activity will account for a 10 dB decrease in average noise levels to 28 to 33 dBA at the nearest residences.

5.2.6.4 Phase III Construction Noise

Approximately 70 workers will be directly involved with the operation of earth-moving equipment, rock drills, and blasting activities during the noisiest stage of Phase III construction. Noise levels and impacts to those workers are similar to those described in Subsection 5.2.6.1.

5.2.6.5 Phase III Operation Noise

The number of noise sources during Phase III operation will be significantly increased over Phase II because of increased capacity, additional processing, and associated increase in pieces of equipment. Phase III operation is also expected to expand and intensify areas of excessive occupational noise levels over Phase II. Because of the new equipment and processes employed, a revision of Phase II noise control techniques and procedures may be necessary to limit employee noise exposures.

5.2.6.6 Phase III Off-Tract Noise

The expected maximum excavation and blasting noise levels at Bonanza caused by Phase III construction are shown in Table 5.2-4. A comparison of these expected maximum noise levels with HUD and EPA criteria shows that no significant noise impact on the residents of Bonanza is expected during Phase III construction.

Facility operation during Phase III will involve a large number of noise sources that will generally increase noise levels (over those of Phase II) near the process area and other parts of the facility. Noise propagated to the off-tract community of Bonanza is expected to increase only marginally. Noise levels at the nearest residence in Bonanza during facility operations are projected to be 25 to 30 dBA, well inside the range of measured background levels (see Subsection 2.3.5).

Traffic volumes are expected to peak during this period because of the simultaneous influx of construction and operating personnel and supplies. A projected increase of 18 to 25 dBA above existing L_{50} noise levels is expected at the nearest residence in Bonanza. This increase may be less than indicated, depending on the extent of bus transportation used in lieu of individual passenger cars. Nevertheless, the resulting L_{50} levels of 48 to 53 dBA are low and fall in the HUD normally acceptable range.

Table 5.2-4

PROJECTED MAXIMUM NOISE LEVELS AT BONANZA
CAUSED BY PHASE III CONSTRUCTION

Construction Activities	A-Weighted Sound Level (dBA)	Peak Sound Pressure Level (dB)	Peak Over-Pressure (lb/ft^2)
Excavation, earth moving, and grading of process area	41	—	—
Blasting of process area and mining and ventilation shafts	—	96	2.63×10^{-2}

5.2.6.7 Phase IV Construction Noise

Approximately 25 workers will be directly involved with the operation of earth-moving equipment, rock drills, and blasting activities during the noisiest stage of Phase IV construction. Noise impacts on these workers are similar to those described in Subsection 5.2.6.1.

5.2.6.8 Phase IV Operation Noise

An increase in the number of noise sources will accompany the increased output capacity of the facility. Noise levels may increase in certain worker areas where the augmented capacity dictates larger concentrations and greater intensities of major noise sources. But since Phase III and IV processes are similar, specific noise control strategies and procedures established for Phase III should be readily adaptable to limit employee noise exposures during Phase IV.

5.2.6.9 Phase IV Off-Tract Noise

The noise level at Bonanza during Phase IV construction will be affected both by the construction and by Phase III operation. The expected maximum total noise levels under this condition are presented in Table 5.2-5.

Table 5.2-5

PROJECTED MAXIMUM NOISE LEVELS AT BONANZA
DURING PHASE III OPERATION AND PHASE IV CONSTRUCTION

Construction Activities	A-Weighted Sound Level (dBA)	Peak Sound Pressure Level (dB)	Peak Over-Pressure (lb/ft^2)
Excavation, earth moving, and grading of process area, and operation of Phase III facilities	35	—	—
Blasting of process area and mining and ventilation shafts	—	86	8.3×10^{-3}

When Phase IV construction is completed and heavy construction machinery removed, noise levels will decrease. Levels of 28 to 33 dBA are expected at the nearest residence in Bonanza as a result of Phase IV operation. These levels are within or slightly above the range of existing background levels. The facility-generated noise is expected to be at most barely audible and will probably be indistinguishable from the existing ambient level in Bonanza.

When traffic volumes caused by construction personnel decrease as the project nears completion, traffic noise will correspondingly decrease. The L_{50} levels of 29 to 34 dBA projected at the nearest residence in Bonanza are a result of traffic noise during the full-scale Phase IV operation. These levels are well within the HUD acceptable range.

Section 5.3

Section 5.3

EFFECTS ON WATER RESOURCES

The construction and operation of the mine and processing facilities will produce changes in the water resources of Tracts U-a and U-b. Alterations in surface drainage will occur as a result of project activities. Contaminated runoff will be intercepted and contained in the retention dam and holding basin. At decommissioning, the holding and freshwater reservoirs will contain uncontaminated water that may be of value to wildlife. Mine dewatering is not expected to have an effect on groundwater hydrology. Contaminated water that infiltrates into the alluvium will be contained upstream from dam structures.

5.3.1 SINGLE RETORT OPERATION – PHASE II

5.3.1.1 Construction Effects

Surface Water Hydrology. Construction will affect approximately 245 acres of land that will be cleared and graded for ore storage and the auxiliary facilities of Phase II. Changes in surface relief resulting from site preparation will alter runoff patterns, and the removal of overburden and subsequent paving of the site will change the rate of runoff during rainstorms. Drainage control facilities will be built to divert storm runoff to the wastewater and storm runoff holding basin to minimize surface erosion. Effects on drainage will be minimized by the appropriate drainage structures. The overall net effect of construction on the surface hydrology of Tracts U-a and U-b should be negligible.

Surface Water Quality. Drainage control and temporary sediment retention structures will prevent contamination of the White River. Construction of the water intake pumping station on the White River

may produce localized sediment concentrations higher than normal. This, however, will be a temporary effect.

Groundwater Hydrology. Construction of the plant and access facilities will have a negligible effect on the groundwater hydrology. No interaction with the Bird's Nest Aquifer is expected. Proposed mine shafts in the vicinity of any water bearing zone will be lined and grouted.

Groundwater Quality. It is expected that the effects produced by construction on groundwater quality will be negligible.

5.3.1.2 Operation Effects

Surface Water Hydrology. During Phase II, a small retention dam will be built in a small side canyon on the eastern slope of Southam Canyon, as shown in Figure 3.10-3. This dam will form an impoundment of sufficient size to contain all surface runoff from a 100-year storm in a drainage area of 500 acres. As a result, any storm runoff flowing from this drainage basin will be impounded. The water collected in this impoundment will be used for dust control or compaction at the processed shale disposal site. (During Phases III and IV, this dam will be covered over with processed shale.) Surface water hydrology in the remainder of Tracts U-a and U-b will not be affected during Phase II.

The effects of the water supply well system on river hydrology will be minimal since an amount no greater than 400 gpm of water will be withdrawn from the White River for process water.

Surface Water Quality. Contaminated water will be intercepted and used in the processing activities. No other effects are expected.

Groundwater Hydrology. Neither mine dewatering nor surface water is expected to have any significant effects on groundwater hydrology.

Groundwater Quality. Changes in groundwater quality during the single retort operation will be restricted to the shallow alluvium upstream of impoundments containing contaminated water.

5.3.1.3 Effects Off Tract

Phase II activitities are not expected to affect surface and groundwater hydrology and quality on land outside Tracts U-a and U-b. Water will be withdrawn from the White River under approved water rights and will amount to less than 5 percent of the minimum river flow.

5.3.2 COMMERCIAL OPERATION PHASE – PHASES III AND IV

5.3.2.1 Construction Effects

Surface Water Hydrology. Construction effects during expansion to Phases III and IV will be similar to those described in Subsection 5.3.1. As more land is cleared and paved or developed, more runoff drainage controls will be built. The effects on surface water hydrology will be minor.

Surface Water Quality. The effects on surface water quality produced by construction in Phases III and IV will be similar to those in Phase II.

Groundwater Hydrology. The effects produced by construction on groundwater hydrology are expected to be negligible since groundwater zones above the mining operations will be sealed at the mine shafts.

Groundwater Quality. The effects produced by construction on groundwater quality will be negligible.

5.3.2.2 Operation Effects

Surface Water Hydrology. During Phases III and IV, changes in surface water hydrology will occur because of the obstruction of the drainage in Southam Canyon by the retention dam to be built near the mouth of the canyon, the withdrawal of fresh water from the White River, and other drainage control features on Tract U-a.

The retention dam in Southam Canyon will prevent contaminated storm runoff and processed shale leachate from entering the White River. The impoundment will be of sufficient size to contain all surface runoff from a 100-year storm in the Southam Canyon drainage basin. The water collected in this impoundment will be used in controlling dust at the processed shale disposal site. At decommissioning, this impoundment will function as an evaporation pond for the contaminated runoff and leachate water. The water collected upstream of the processed shale will be used in the process activities. At decommissioning, the drainage water collected is expected to be uncontaminated, and will be allowed to evaporate.

The deposit of processed shale will become a barrier to surface water flow in Southam Canyon. It will also be designed to become a moisture trap and to prevent large runoffs from accumulating in the downgrade impoundment. The upper surface of the processed shale deposit will be contoured into depressions to collect precipitation in shallow sinks to allow for evaporation or penetration into the processed shale for use in revegetation. The details of the processed shale surface contour and revegetation plan are presented in Section 3.10.

A small on-tract freshwater reservoir will be built in a natural wash southeast of the processing facilities. Fresh water storage for 3 days will be contained in this reservoir, and in addition it will provide flood protection from a 100-year storm. At decommissioning, this impounded

water could support wildlife; it will continue to operate as an evaporation pond and a sediment catchment basin. The wastewater and storm runoff holding basin will be designed in accordance with the lease stipulations (see Section 4.4). At decommissioning, it will be cleaned of contaminants and will continue to function as an evaporation pond retaining sediments and uncontaminated drainage water.

An increasing volume of water will be withdrawn from the White River reservoir. It is estimated that approximately 5,000 to 10,000 gpm will be withdrawn during Phase III and 8,000 to 16,000 gpm during Phase IV (see Section 7.14).

Neither the mine operation nor other operation of the facility, including the use of roadways, is expected to have any appreciable effect on the surface runoffs. At the process and storage areas, however, storm runoff from the tank farms, ore storage sections, and process buildings will be channeled into ditches and conduits to be collected for treatment. Treated runoff will be discharged into the holding basin downgrade from the process facility and will be used for dust control.

Surface Water Quality. Storms and snowmelts will produce intermittent and measurable surface runoff and leachate that will be contaminated by suspended solids and salts from the deposited processed shale. This water will be contained behind the Southam Canyon retention dam. For further elaboration on the processed shale disposal plan, refer to Section 3.10.

The degree of contamination of leachate will depend largely on the composition of processed shale, infiltration, percolation and solute leaching rates, time, and other factors. Since these parameters are not precisely

known, the chemistry of surface leachate water in Southam Canyon cannot be predicted accurately. Preliminary tests, however, on similar surface leachates have suggested the presence of high concentrations of inorganic ions, especially those of sodium and carbonate, and a 10 to 12 pH (Ref. 36 ; see also Subsection 3.10.2.). Water with this general chemistry is known to be toxic and unfit for either wildlife or irrigation (Ref. 52 ; see also Subsection 4.4.3.3.)

Drainage water and wastewater streams within the processing area will be treated, discharged to the holding basin, and used in the various process activities. At decommissioning, the drainage water is expected to be uncontaminated and will be evaporated from the holding basin.

No significant effects will be produced on water quality by Phases III and IV on either the White River or off-tract waterways and drainage basins.

Groundwater Hydrology. Mining production will approach 160,000 TPCD during Phases III and IV. The overall effect on groundwater is expected to be negligible.

Subsidence is expected to be minimal. Mining operations, however, may produce enough subsidence to cause fracturing of the rocks above the Mahogany zone; this would result in an increase in the permeability of the rocks and would influence dewatering of the mine.

Groundwater Quality. The overall effect of project operation on groundwater quality is expected to be negligible. Contaminated water that may seep into the alluvial materials will be confined to the areas upstream from the impoundment structures. Water percolation into the Uinta formation is expected to be negligible (see Section 4.4).

5.3.2.3 Effects Off Tract

Water will be purchased during Phases III and IV from the White River reservoir with little effect on river flow downstream. Water levels in the reservoir will fluctuate, thus affecting to some extent the aquatic habitats in the reservoir area.

The drainage control facilities will be designed to ensure protection of the off-tract groundwater systems against contamination.

Section 5.4

Section 5.4

EFFECTS ON BIOLOGICAL RESOURCES

The intent in the following assessment is to identify the expected major changes in the biological resources of the area and to set the stage for the design and implementation of the wildlife management plan and ongoing monitoring program.

A three-step approach has been followed: First, the acreage of each vegetation type to be altered during the construction and operation of the project is reported and the general effects on the associated biota are reviewed. Second, on the basis of the present estimates of species composition of each vegetation type, the cumulative effects of habitat loss or alternation are assessed for major groups of organisms. And third, the potential impacts on threatened or endangered species on the tracts are presented.

5.4.1 AFFECTED PLANT AND ANIMAL COMMUNITIES

As discussed in Section 2.5, the plant and animal species on the tracts tend to occur in four rather distinct biological communities: the sagebrush-greasewood, juniper, shadscale, and riparian vegetation types. In the course of implementing the full-scale White River Shale Project, all four vegetation types will be affected to some extent. Two major areas will be altered:

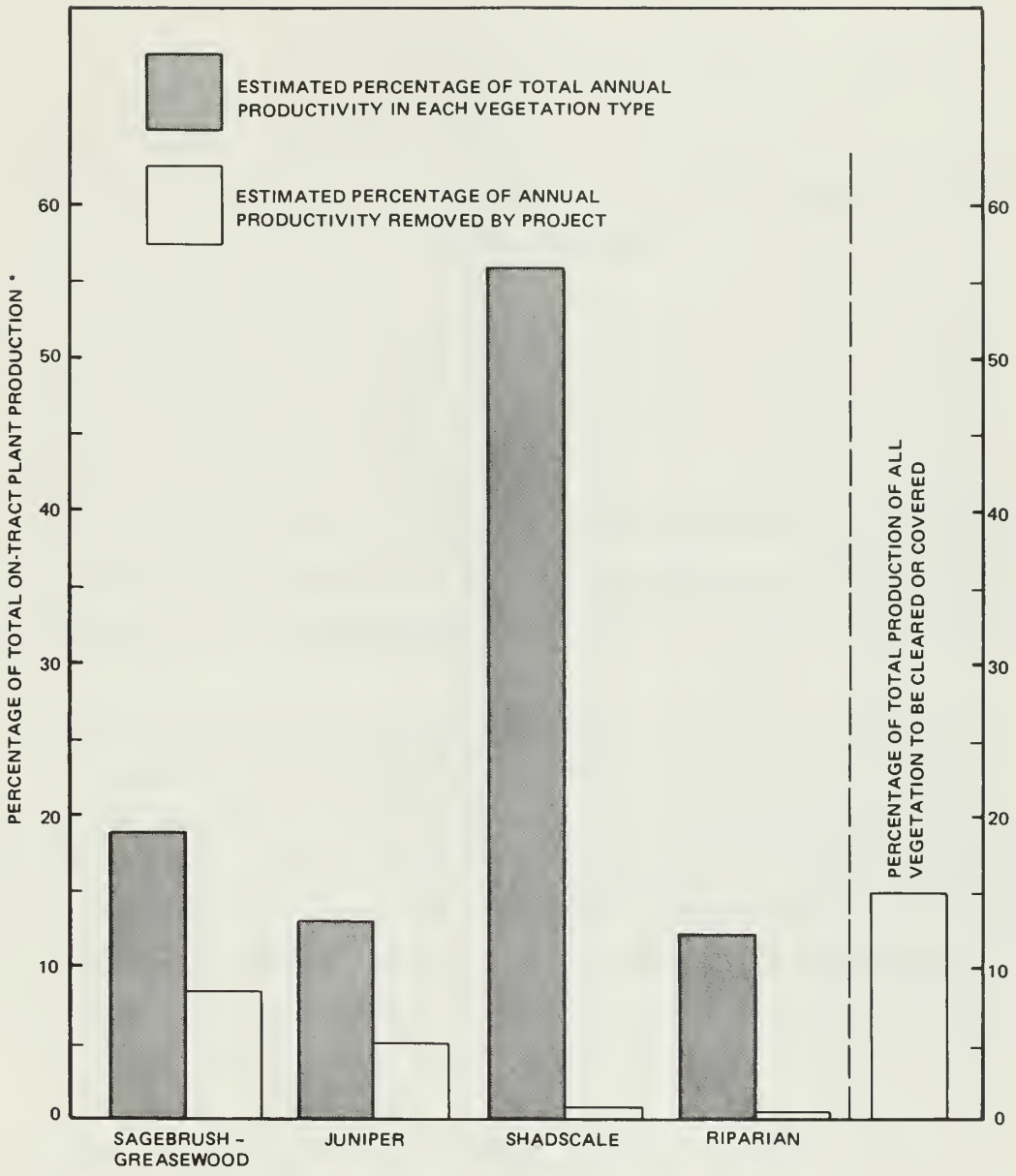
- The site of the process facilities, where the bulk of construction activity will occur
- The processed shale disposal area, where the major biological impacts of facility operation will occur

Process facilities will be in the northeastern portion of Tract U-a and the western portion of Tract U-b, as shown in Figure 5.4-1. They will ultimately occupy an area of approximately 400 acres, 185 acres of which will be cleared during construction. Shale disposal will take place within Southam Canyon (in the southeastern and central portion of Tract U-a). At the exhaustion of the oil shale resource, the processed shale and the Southam Canyon retention dam will cover approximately 2,200 acres. Approximately 100 additional acres will be affected in various transportation corridors. The total area affected will be approximately 2,630 acres (4 square miles) of the total of 10,240 acres (16 square miles) on the tracts. The plant and animal communities in the two major areas will, in effect, be removed from the regional ecological system during the 25-year life of the project. The actual loss of habitat will be progressive, however, especially in Southam Canyon, and will be counterbalanced by the continuing restoration of disturbed lands and the vegetation of the processed shale pile.

The biological character of the two major areas is essentially the same: they both support mixed stands of sagebrush-greasewood and juniper vegetation types in roughly the same proportions, as shown in Figure 5.4-1. The project will have only a minor direct impact on the highly productive riparian habitat and the aquatic ecosystem. Riparian vegetation will be affected by the installation and operation of water supply wells and pumps during Phase II. Shadscale vegetation will be affected by the installation of other project facilities, such as utilities, water and product pipelines, and access roads. Although the affected areas represent approximately 25 percent of the tracts, analysis of the baseline data suggests that there may be, as a worst case, only about a 15 percent loss of the total on-tract productivity, as shown in Figure 5.4-2. It can be seen in the figure that the two most productive vegetation types — the shadscale and the riparian — will be left relatively undisturbed, reducing the potential overall loss of productivity.

NOTE: Map based on VTN uncontrolled photo mosaic of the area.

Figure 5.4-1. Map of Tracts U-a and U-b, Showing Project Layout in Relation to Vegetation Distribution



* Based on 1975 baseline data on productivity of annuals and perennials (see Table 2.5-2). Actual productivity in each vegetation type and the relative productivity of vegetation types may vary from year to year.

Figure 5.4-2. The Relative Impact of the Project on Total On-Tract Plant Productivity

5.4.1.1 Impacts of Facilities Construction

Facilities construction will directly affect about 185 acres within the process area, including 44 acres during the single retort operation phase and 140 acres during the commercial operation phases. Table 5.4-1 summarizes the amount of each vegetation type that will be affected. Utility corridors, access roads, and a water pipeline may be installed during the single retort operation phase, and these could ultimately affect an additional 11 acres of sagebrush-greasewood, 22 acres of juniper, and 46 acres of shadscale. The sagebrush-greasewood, although less productive than shadscale, has higher forage value for sheep and wildlife. Because sagebrush-greasewood occurs on deeper, less saline soils, it has a potential for greater productivity through range management practices than either the juniper or shadscale. Juniper vegetation has the lowest forage value for most wildlife species and for livestock. As much as 10 percent of the construction zone for the process area, 50 percent for the access roads, and over 95 percent for the pipelines will be revegetated.

As vegetation is removed or destroyed, the area will become incapable of supporting the normal resident and transient animal populations. Most highly mobile animals, such as large mammals, birds, and flying insects will leave; less mobile small rodents, reptiles, and insects may be destroyed along with the vegetation. Those animals forced away from the construction site will move into presently occupied neighboring areas, thereby increasing the competition for food and shelter and increasing exposure to predation. Animal populations in the affected areas will restablize over a period of time. This process of stablization may be relatively short-term and will be limited to a small area surrounding the preempted acreage. When viewed in the regional context, the nearly total loss of affected vegetation and wildlife on the tracts in the construction areas is expected to be minor because of the vast contiguous area of similar habitat.

Table 5.4-1

ESTIMATED ACREAGE[(a)] TO BE REMOVED FROM EACH VEGETATION COMMUNITY DURING THE PROJECT

		Vegetation Type								Total Acreage	
		Sagebrush-Greasewood		Juniper		Shadscale		Riparian			
		U-a	U-b	U-a	U-b	U-a	U-b	U-a	U-b	U-a	U-b
Acreage of Disturbed Habitat — Single Retort Operation Phase	Facilities construction										
	Site preparation										
	Disturbed habitats	14	0	30	0					44	0
	Utilities corridors and access roads	0	11	0	22	0	22			0	55
	Pumping station							0	1	0	1
	Facilities operation										
	Processed shale disposal and retort catchment	50	0	100	0					150	0
	Subtotal	64	11	130	22	0	22	0	1	194	56
Acreage of Disturbed Habitat — Commercial Operation Phase	Facilities construction										
	Site preparation	50	0	90	0					140	0
	White River Dam							2,060[(b)]			
	Utilities corridors (new disturbance)	5	0	5	0	0	21			10	21
	Pumping station					0	3			0	3
	Facilities operation										
	Processed shale disposal and retention dam	1,108	0	1,098	0					2,206	0
	Subtotal	1,163	0	1,193	0	0	24	0	0	2,356	24
	Total disturbed acreage	1,227	11	1,323	22	0	46	0	1	2,630	
Acreage of Undisturbed Habitat	Total acreage of U-a and U-b	2,220	560	2,735	1,140	0	3,370	165	50	5,120	5,120
	Total disturbed acreage	1,227	11	1,323	22	0	46	0	1	2,550	80
	Total undisturbed acreage	993	549	1,412	1,118	0	3,324	165	49	7,610	

(a) All numbers are approximate.
(b) Most of this disturbance is off tract.

No major impacts on aquatic habitats are anticipated from construction of facilities during either the single retort operation or commercial operation phases. The White River will undergo significant change when the White River Reservoir is constructed. The relationship of this independent activity to the White River Shale Project is summarized in Exhibit 5.4-1. Prior to the filling of the reservoir, there may be minor impacts associated with the construction of the pump station and well system near the White River for the single retort operation phase. Construction of the pump station may locally affect resident species (e.g., deer and Canada geese) in the riparian zone. Surface runoff will bring about minor changes in water quality (in the form of suspended solids), but these changes are expected to be indistinguishable from the effects of ambient turbidity on algae or insect larvae in the river.

5.4.1.2 Operational Impacts

Processed Shale Disposal. The operation of process facilities will ultimately produce about 129,000 tons per day of processed shale, which will be disposed of in Southam Canyon. A total of approximately 2,360 acres will be covered by the shale pile and the Southam Canyon retention dam during the life of the project — 150 acres during Phase II and 2,210 acres during Phases III and IV. The estimated amount of each vegetation type that will be removed is also shown in Table 5.4-1.

The primary and secondary impacts of habitat loss and displacement of wildlife in Southam Canyon will be the same in nature as those impacts associated with construction of process facilities. However, the impacts will be greater in magnitude since the acreage affected in Southam Canyon is approximately six times larger than the acreage affected in the area of the process facilities. A more detailed discussion of impacts on specific faunal groups is found in Subsection 5.4.2.

Exhibit 5.4-1

THE STATE OF UTAH
WHITE RIVER RESERVOIR PROJECT
Changes Expected in Baseline Conditions

The most probable water source for the commercial operation phases of the White River Shale Project is the White River Reservoir, proposed by the State of Utah. The water supply alternative study for the shale project, prepared by Bingham Engineering, has been submitted as an accompanying document to the DDP. The White River Reservoir Project, however, is independent of the White River Shale Project; the evaluation of the environmental effects of the construction and operation of the reservoir is the responsibility of the project sponsor.

Although almost all of this reservoir will be located off tract, it will have some impacts on on-tract terrestrial and aquatic habitat behind the dam. A large portion of the riparian habitat (approximately 150 acres) and the riverine habitat found on the tracts will disappear as a result of the proposed dam. Within the tracts, changes in the biological baseline that can be expected to occur because of inundation can be important in the analysis of impacts from the commercial phases.

The withdrawal of water to supply the White River Shale Project, on the other hand, will have some effect on the conditions in the new reservoir and must be evaluated in the DDP. An evaluation of the modified baseline conditions after the reservoir process is completed is summarized below. This evaluation is based on a letter of 30 January 1976 from Mr. D.F. Lawrence of the State of Utah Division of Water Resources to Mr. M.L. Littlewood of the White River Shale Project.

- The populations that the riparian habitat now supports will be destroyed or displaced to upstream and downstream riparian areas or to surrounding sagebrush-greasewood and shadscale habitats, which are markedly different from the riparian. Because of shallow soils and an anticipated 30-foot fluctuation in water level, it is unlikely that a new riparian habitat will be established along the shoreline.
- A turbid riverine habitat with a rubble and silt substrate will be transformed into a long (approximately 11 miles), deep (about 110 feet maximum), relatively clear lake. At times, the lake will stratify: the colder waters will be at the bottom and the warmer waters at the top. This stratification will be broken up at the inflow point of the White River by White River flows and elsewhere on the lake by wind-induced circulation. It will also be broken up by changes in water temperature during spring and fall (spring and fall turnover). The surface layers will be relatively clear, since, with decreased water flow rates, some suspended solids carried by the river will settle out. Year-round water quality conditions will be more uniform in the lake than in the river.
- The organic material now found in the White River Basin will be an additional source of nutrients and is expected to support a potentially large fish population. The species composition of this fish population will depend upon existing natural conditions in the reservoir and on man-controlled factors such as stocking of fish.
- The currently typical aquatic insect periphyton communities will decrease in size, being limited to shallow reservoir backwaters that resemble present White River habitats. The major open-water portion of the reservoir will likely be characterized by phytoplankton and zooplankton not now found in the White River.

Air Emissions. During the life of the project, federal and state ambient air quality standards for sulfur and nitrogen oxides will be met. Because primary and secondary air quality standards are designed to protect humans, flora, and fauna from the effects of gaseous pollutants, and because desert venetation is highly resistant to damage from these gases (Ref. 53), no biological damage from sulfur and nitrogen oxide emissions during normal operations is anticipated (see Table 5.3-2 and Section 4.2).

The calculated maximum fugitive dust deposition will occur along a zone approximately 2 miles long, north by northwest from the process facilities, as shown in Figure 5.2-1. At this location, dust will be deposited at the rate of approximately 0.02 pound per square foot per year in a layer about 0.0033 inch thick. However, since leaves are freed from dust regularly by wind and rain, the actual dust layer on the leaf surface will probably be only a fraction of the projected annual deposition thickness at any given time. Fugitive dust from the White River Shale Project will consist almost entirely of particles of shale. The dust is dark gray and has chemical properties as described in Section 4.6.3, "Surface Rehabitation and Revegetation," (Ref. 36). There is no information available at this time to allow a rigorous assessment of the impact that dust with these properties will have on vegetation or other biota. However, the effects of processed shale dust on plant growth will be examined as part of the shale pile vegetation program.

Water Effect on Biota. No wastewater streams will be discharged to surface waters. Normal storm runoff from the tracts may be contaminated with leachate from localized deposits of fugitive dust.

Water quality sampling during the monitoring program will detect any significant contamination of surface waters in advance of potential biological damage.

The use of a well system for a water supply requirement of approximately 200 gallons per minute in the single retort operation phase will not affect the aquatic community in the White River because no aquatic biota can be entrained in this type of delivery system. However, increased consumption during commerical operation may affect the biota of the White River Reservoir. The minimum consumption of 8,000 gpm (two-train operation) constitutes less than 3 percent of the average White River flow into the proposed reservoir. Under maximum conditions, consumption will increase to 16,000 gpm; 10 percent (worst-case conditions) of the plankton, fish eggs, and fish larvae in the reservoir might be expected to be lost through entrainment during the course of facility operation. But such uniform distribution of biota does not normally occur in reservoirs. Moreover, the following mitigation measures incorporated into the location and design of the intake structure will minimize the entrainment of aquatic biota:

- Location in deeper water (40 feet) will reduce the entrainment of phytoplankton and zooplankton. These organisms are more commonly located in the euphotic zone (the surface of a lake that receives sufficient light for the fixation of carbon by plants) and will, therefore, normally be unaffected by pumping.
- The use of fixed screens on the intake will reduce entrainment of fish, minimizing impacts on populations of these species.
- The design of the intake structure for an intake velocity of 0.5 foot per second or less will allow most fish to avoid entrainment, further reducing impacts on these species.

The actual entrainment of biota, therefore, is not expected to significantly affect the ecological structure of the population sizes in the reservoir: a decrease of less than 3 percent of the population of an aquatic species is less than the normal seasonal fluctuation of many species populations. For example, rotifer and cladoceran populations (zooplankton typical of lakes) have been shown to fluctuate by as much as 100 percent over a 4-month period (Ref. 54).

Increased Human Use of Tracts. The expected influx of people either directly or indirectly associated with the development of the project will have an impact on the habitat and on the wildlife in the area. Increased noise, vehicular activity, and visibility of people around the area will directly affect wildlife populations, causing sensitive species, such as deer, raptors, and some song birds, to avoid intensively used areas. Migration of these animals to surrounding habitats will probably result in more competition and predation in these areas, and the animals that the surrounding habitat cannot accommodate may die.

Greater recreational use will be made of the area. Increased hunting and fishing will directly affect wildlife populations and will most likely reduce populations of game species. In addition, any off-road use of recreational vehicles will disturb the shallow soils and the plants they support and hence further disrupt habitats in the area. White River Shale Project will work with the Utah Division of Wildlife Resources, the Bureau of Land Management, and others to minimize these effects. (This is discussed in Section 4.7, the Fish and Wildlife Management Plan.)

5.4.2 IMPACTS ON MAJOR FAUNAL GROUPS

5.4.2.1 Mammals

Mule Deer (Odocoileus hemionus). Because of the pattern of seasonal use and distribution of the deer population on the tracts, the local deer herd will be only marginally affected by the planned development of the White River Shale Project. Deer use of Southam Canyon is presently very light; consequently, only a minor amount of deer habitat will be lost as the canyon is filled. The process area contains both juniper and sagebrush-greasewood vegetation types, which are thought to be the preferred wintering habitat for deer. Construction of the process area will remove 400 acres or more from use and will probably displace a small herd of approximately 25 deer that was observed wintering in the vicinity in February 1976. As discussed in Section 4.7, alternative habitat will be established to accommodate these deer and other wildlife displaced by the project.

The expected influx of people will increase ambient noise levels and other disturbances on and near the tracts. These changes in ambient conditions could force the deer away from their primary summer habitat along the White River. With the construction of the White River Dam, however, the deer will be permanently displaced from the flooded riparian habitat.

Livestock. As a result of the construction and operation of the project, approximately 2,750 acres of sheep grazing land will be removed from use in the Southam and Wagon Hound Allotments (see Figure 2.5-3). As shown on Table 5.4-2, this represents a loss of approximately 188 animals unit months (AUMs), or approximately a 7 percent reduction in current grazing levels. An additional number of sheep would be restricted from the tracts as part of the enhancement program for the Fish and Wildlife Management Plan (see Section 4.7).

Table 5.4-2

GRAZING UTILIZATION[a]

Allotment	Acres Lost	Average AUM[b] per acre	Average AUM Lost per allotment
Southam	2,350	0.066	155
Wagon Hound	400	0.083	33
Total	2,750		188

(a) All numbers are approximate
(b) Current Bureau of Land Management data

Small Mammals. The Apache pocket mouse, the deer mouse, the desert woodrat, and the desert cottontail rabbit — the most common small mammals in the area — are found in all four vegetation types on the tracts, and hence will be affected by the construction and operation of the project. Nearly all individuals of the burrowing species will be permanently lost; the larger nonburrowing species will tend to be displaced during site preparation and during the deposition of processed shale within Southam Canyon. While these losses will be locally substantial (between 30 to 35 percent of the on-tract populations), regional impacts may not even be measurable. The nearly total loss of rodents in the disturbed areas is not an irreversible, long-term loss. Almost all the species affected have a high reproductive potential and can recover from population losses of this magnitude in a few generations. In addition, rodents are expected to be among the first vertebrate groups to become reestablished on the vegetated processed shale pile and in revegetated disturbed areas.

5.4.2.2 Avifauna

Song Birds (Passeriformes). Bird populations will be affected through loss of breeding sites, cover, and food resources. The effective decrease in available on-tract bird habitat will be approximately 2,630 acres and will reduce the ground and shrub nesting population between 25 and 30 percent. A detailed discussion of species diversity and density of birds in each vegetation type can be found in Section 2.5.4.4. Because birds are highly mobile, most individuals will leave the areas of activity. Displacement of birds may cause a temporary increase in competition in adjacent habitat, and this competition may be particularly intense for species such as pinyon jays, sage sparrows, and Brewer's sparrows that nest in the area. Nearly all songbird species identified in sagebrush-greasewood and juniper vegetation types in June 1975 were breeding and, therefore, would be affected. The effect of this small loss of habitat to nonbreeding migrants such as darkeyed juncos and black and gray rosy finches will be minor: they normally wander widely over the region and do not rely on small, fixed territories to assure a food supply.

Raptors. Of the five raptor species known to nest in the area, only the rare prairie falcon was known to have nested on the tracts in 1975, and only one nest was located. (The prairie falcon was removed from the federal list of endangered and threatened species in 1974.) The process area is approximately 0.5 mile from the nest site; the nearest edge of the processed shale pile is 0.4 mile from the nest site. Neither the construction nor the operation of the White River Shale Project will destroy the nest site, but project-related noise and equipment traffic will probably cause the nest to be abandoned.

The preemption of land and the associated displacement of prey species, such as rodents, reptiles, and smaller birds, may temporarily benefit the raptor populations by locally increasing the availability of prey. However, the on-tract loss of habitat will result in a reduction of available

food until revegetated areas are well established. The 2,630 acres (4 square miles) disturbed on-tract are equivalent to about 12 percent of the 33.5 square mile nesting territory reported (Ref. 55) for a pair of golden eagles, the largest raptor nesting in the vicinity of the tracts. Nesting territory sizes reported (Ref. 56) for the prairie falcon and American kestrel are approximately 10 square miles and 0.4 square mile, respectively. Although these data are not directly applicable to the on-tract raptors, they are indicative of the relative requirements for hunting range exhibited by these species.

5.4.2.3 Reptiles

As is the case with other terrestrial groups, reptile populations will be lost as the vegetation is cleared or covered with processed shale. Since the disturbed areas account for about 25 percent of tract acreage, the local reduction of the reptile populations may be large, in absolute numbers, perhaps as much as 30 to 40 percent of the total number on the tracts. But since no regionally rare or unique species are restricted to the tracts and since the tracts constitute a very small portion of the available habitat in the surrounding Uinta Basin, no significant regional impacts are anticipated.

5.4.2.4 Amphibians

Construction and operation activity for the wells and pump station for the single retort operation phase will not seriously affect local amphibian populations. Approximately 1 acre of riparian habitat will be preempted because of these construction activities, but available data indicate the number of amphibians expected to occur on 1 acre of riparian land is low.

5.4.2.5 Invertebrates

The construction and operation of the White River Shale Project are not expected to measurably change the number or diversity of arthropod species in the region. Although the loss of upland habitats will at first diminish the arthropod populations ontract, the high reproductive potential of most arthropod species will enable them to recover very rapidly from these initial population reductions.

5.4.2.6 Microorganisms

Direct impacts on soil microorganisms are expected to be highly localized. Since soil microbial activity is primarily limited to surface layers and is associated with vegetative cover, the diversity, number, and activity of the microorganisms will be reduced or lost whenever topsoil is turned over, stored, or covered for any length of time. Localized direct impacts (i.e., habitat loss) to soil microorganisms will occur in Southam Canyon as a result of deposition of processed oil shale. As the processed shale reaches the bottomlands of the canyon, some of the existing soil will be removed, and used as a substrate in the processed shale revegetation program. The resultant loss of soil microorganisms will have an insignificant effect on the productivity and the total ecology of the region. With time, the processed shale will develop a new microflora and fauna as it changes from an inert waste material to a productive soil.

Soil microorganisms may be adversely affected by leachate from processed shale dust distributed by wind outside the Southam Canyon disposal area. Monitoring of microbial activity, as described in Part 6, will provide methods for detecting such changes should they occur.

5.4.3 IMPACTS ON ENDANGERED OR THREATENED SPECIES

5.4.3.1 Endangered or Threatened Fauna

Raptors. One endangered raptor species, the peregrine falcon (a predator on other birds), has been observed near the tracts, but no breeding sites have been located in or near the study area. It is anticipated that these casual visitors will avoid the area, and will be only marginally affected by the White River Shale Project.

Fish. The endangered Colorado River squawfish (Ptychocheilus lucius), the humpback chub (Gila cypha), the very rare bony-tailed chub (Gila elegans), or the humpback sucker (Xyrauchen texanus) have not been found on or near the tracts during the first year baseline data collection program.

Invertebrates. The swallowtail species (Papilio), which may soon be placed on the endangered species list, is not expected to be significantly affected by White River Shale Project. The carrot-like plants (Umbelliferae) on which its larvae subsist occur primarily in the shadscale habitat, which will be relatively undisturbed by project construction and operation.

5.4.3.2 Endangered or Threatened Flora

The threatened species, Gilia mcvickerae, is normally found within the sagebrush-greasewood and juniper habitats, but has not been observed ontract. A total of 1,238 acres of sagebrush-greasewood and 1,345 acres of juniper are being eliminated or covered, which represents a potential for the destruction of some of these threatened plants.

Section 5.5

Section 5.5

SOILS AND GEOLOGY

The White River Shale Project will alter the topography of Tracts U-a and U-b, particularly in Southam Canyon. Mining operations will also remove a major part of the oil-rich Mahogany zone that underlies the area. This section presents findings based on studies of soils and geology that were initiated to determine both existing conditions at the site and the probable effects of construction and operation of the project.

5.5.1 SINGLE RETORT OPERATION

Construction of Phase II will affect the soil management, topography, and minerals of Tracts U-a and U-b to varying degrees, as described in the following paragraphs.

5.5.1.1 Construction Effects on Soil Productivity

The soils on Tracts U-a and U-b are generally coarse and contain long thin sandstone fragments, as shown in Table 5.5-1. Situated in an arid environment, these soils are moderately alkaline, generally shallow, have low water-holding capacity, and are not suited for row crops; however, they support desert vegetation, wildlife, and, in the winter, sheep. Bureau of Land Management records show that the Southam Canyon allotment has a productivity of 0.07 animal unit month (AUM) and currently supports approximately one sheep on 34 acres.

With so little land, approximately 185 acres, being preempted by construction, the regional effect on soil productivity should be minimal.

5.5.1.2 Construction Effects on Soil Erodibility

Some erosion of soil is anticipated during construction. Drainage structures, however, will minimize long term effects of erosion. Tank farms and other fire-sensitive areas will not be revegetated, but may be chemically treated for soil stabilization.

A detailed description is given in Table 5.5.1 of the soils that will be affected by access roads, the plant site, processed shale deposits, and pipeline corridors. This table also points out that soils in these areas are rated moderate to severe in erodibility.

5.5.1.3 Construction Effects on Topography

Site preparation for single retort operation will require grading and leveling of approximately 44 acres. In addition, 55 acres will be needed for the development of facilities such as pipelines and roads. Other construction activities, such as diversion ditches, small retention dams, and power corridors, will result in minor changes to topography.

5.5.1.4 Construction Effects on Subsurface Zones

Subsurface operation during Phase II will necessitate sinking two vertical access shafts to the oil shale. Because a small amount of material will be extracted by construction of these shafts, the effects should be negligible, and the mined material (sandstone, siltstone, marlstone, and kerogen-rich marlstone or oil shale) will be deposited in a small side canyon within Southam Canyon or used in the construction of drainage facilities.

5.5.1.5 Construction Effects on Mineral Resources

Construction should have no effect on mineral resources.

Table 5.5-1

CHARACTERISTICS OF SOILS AFFECTED BY OIL SHALE DEVELOPMENT

Mapping Unit		Soil Type	Dominant Texture	Soil Depth (inches)	Erosion Hazard	Present Use	Slope (%)	pH Range[a]	Permeability	Runoff	Water[b] Holding Capacity (inches)	Vegetation
ACCESS ROAD												
1.	As5	AsC-Unita sandstone complex	Channery[c] sandy loam	12-19.5	Moderate	Winter sheep grazing, wildlife habitat	10-20	8.0-8.9	Moderate	Medium	1	Mainly sagebrush and shadscale
2.	A3	AC-BD complex	Channery loam	12-19.5	Moderate	Winter sheep grazing, wildlife habitat	10-40	8.0-8.7	Moderate	Medium to low	1 to 2	Shadscale, black sage, rabbitbrush, needlegrass
3.	FR	F-loams sand Unita complex	Loamy sand	4-15.5	Moderate-severe	Wildlife habitat and winter sheep grazing	3-7	8.1-8.5	Moderate to rapid	Medium to high	0.6 to 1	Spring hopsage, rabbitbrush, black sagebrush
4.	ND	ND-DsB complex	Fine sandy loam	50-60	Moderate	Wildlife habitat and winter sheep grazing	5-10	8.7-8.3	Low	Moderate to rapid	6-8	Greasewood, shadscale, hopsage, and annual weeds
5.	D	D-sandy loam	Sandy loam	60	Moderate	Wildlife habitat and winter sheep grazing	5-10	8.0-8.2	Moderate	Medium	7-8	Sagebrush, greasewood, fourwing saltbrush, rabbitbrush
6.	As1	AsC-BsC complex	Channery sandy loam	12-19.5	Moderate	Wildlife habitat and winter sheep grazing	10-20	8.0-8.9	Moderate	Medium	1	Mainly sagebrush and shadscale
7.	Bs5	BsC-Unita sandstone complex	Channery sandy loam	2-10	Moderate-severe	Wildlife and limited sheep grazing	10-20	8.2-8.4	Moderate	Medium to high	0.5	Juniper, black sagebrush, shadscale, rabbitbrush
PROCESS AREA												
8.	Bs5	Same as 7										
9.	D	Same as 5										
10.	As1	Same as 6										
11.	R	Unita sandstone-BsE complex	Massive sandstone	N/a	N/a	None	40-70	N/a	N/a	Rapid	N/a	None
12.	Bs3	Bs3-Units sandstone complex	Very channery and very flaggy[d] sandy loam	2-10	Moderate-severe	Wildlife habitat and limited winter sheep grazing	40-60	8.2-8.4	Moderate	Medium to high	0.5	Juniper, black sagebrush, shadscale, blue bunch wheatgrass
13.	A2	A-channery loam	Channery loam	12-20	Moderate	Wildlife habitat and winter sheep grazing	10-20	8.0-8.7	Moderate	Medium to low	1-2	Shadscale, blacksage, rabbitbrush, needlegrass

Mapping Unit		Soil Type	Dominant Texture	Soil Depth (inches)	Erosion Hazard	Present Use	Slope (%)	pH Range[a]	Permeability	Runoff	Water[b] Holding Capacity (inches)	Vegetation
PROCESSED SHALE DISPOSAL AREA												
14.	Bs3	Same as 12	Channery sandy loam	2-10	Moderate-severe	Wildlife habitat and limited winter sheep grazing	10-20	8.2-8.4	Moderate	Medium to high	0.5	Juniper, black sagebrush, shadscale, blue bunch wheatgrass
15.	D	Same as 5										
16.	Bs4	BS-channery sandy loam										
17.	A2	Same as 13										
18.	As1	Same as 10										
19.	R	Same as 11										
20.	Bs1	BsD-Unita sandstone complex	Channery and flaggy sandy loam	2-10	Moderate-severe	Wildlife habitat and limited winter sheep grazing	20-40	8.2-8.4	Moderate	Medium to high	0.5	Juniper, black sagebrush, shadscale, blue bunch wheatgrass
PIPELINE CORRIDOR												
21.	A4	AB-BD complex	Channery loam	12-20	Moderate	Wildlife habitat, limited winter sheep grazing	20-40	8.2-8.4	Moderate	Medium to low	1-2	Shadscale, blacksage, rabbitbrush, needlegrass
22.	FR	Same as 3										
23.	R	Same as 11										
24.	Bs3	Same as 12										
25.	Bs5	Same as 7										
26.	D	Same as 5										

(a) First figure denotes the pH of the topsoil; the second figure, the pH of the soil just above bedrock.
(b) The moisture data relate to the entire soil depth.
(c) A channery soil is one that contains thin, flat sandstone fragments up to 6 inches along the longer axis.
(d) A flaggy soil is one that has relatively thin sandstone fragments from 6 to 15 inches long.

5.5.1.6 Operation Effects on Soil Productivity

The processed shale from Phase II will cover an area of approximately 120 acres. This should have a negligible effect on soil productivity for the entire region.

5.5.1.7 Operation Effects on Soil Erodibility

Approximately 7,200 TPCD of processed shale will be deposited in a side canyon off the east rim of Southam Canyon, as shown in Figure 3.10-4. A 5 percent slope will be maintained to reduce erodibility as the fill material is placed towards the northwest. At the end of the operation, the processed shale deposit will reach to an average elevation of 5,500 feet while maintaining a gentle slope. Finally, the pile surface will be contoured to reduce erosion, as described in Subsection 4.6.2.

As described in Subsection 3.10.4.3, wind and rain are anticipated to cause some minor erosion of the processed shale deposit before revegetation is completed.

5.5.1.8 Operation Effects on Topography

The major topographic alteration will develop from the processed shale deposit in Southam Canyon, as shown in Figure 3.10-3.

5.5.1.9 Operation Effects on Subsurface Zones

A two-bench room and pillar mining system that could yield a resource recovery of about 70 percent of the defined mining horizon is proposed, as described in Subsection 3.5.2.3 and shown in Figure 3.5-6. As a result of the removal of the oil shale zone (Mahogany zone) and the placement of processed shale on the surface, increased stress will occur in the geological foundation. The detailed physical and chemical characteristics of the processed shale are described in Subsection 3.10.2.1.

Additional studies are being made of the chemical properties of the leachate produced by the processed shale, but conclusions are still pending.

5.5.1.10 Operation Effects on Mineral Resources

Effects on existing mineral resources, excluding oil shale, are expected to be negligible.

5.5.1.11 Phase II Effects Off Tract

Since the entire mining operation will be conducted within Tracts U-a and U-b, there will be no appreciable effects related to soils and geology on lands outside the lease property.

5.5.2 COMMERCIAL PHASE OPERATION

5.5.2.1 Construction Effects on Soil Productivity

Because of the low soil productivity exhibited on the lease property, and since construction for Phases III and IV will cover approximately 140 acres, the effects should be minimal.

5.5.2.2 Construction Effects on Soil Erodibility

With the implementation of the soil erosion control plan described in Subsection 4.4.1, soil erosion from construction should be kept to a minimum. The effects of such construction are similar to those described in Subsection 5.5.1.2.

5.5.2.3 Construction Effects on Topography

A permanent retention dam will be built for Phases III and IV in Southam Canyon to contain the contaminated runoff from the processed shale. Other topographical changes caused by construction should be similar to those described in Subsection 5.5.1.3. Expansion of the process area and other facilities, such as construction of the freshwater impoundment, will modify the topography of Tract U-a.

5.5.2.4 Construction Effects on Subsurface Zones

The effects produced by construction on the subsurface, though greater in scope, follow the same pattern as those described in Subsection 5.5.1.4.

5.5.2.5 Construction Effects on Mineral Resources

Construction will have no appreciable effects on existing mineral resources.

5.5.2.6 Operation Effects on Soil Productivity

It is estimated that after 20 years of Phases III and IV, approximately 3.5 square miles of Southam Canyon will have been filled; this is approximately 180 AUM from the land's potential. Revegetation will return equal or greater productivity to the land.

5.5.2.7 Operation Effects on Soil Erodibility

The topsoil classified as D soils and shown in Table 5.5-1 will be placed in trenches in the processed shale deposit to be used for revegetation, as described in Subsection 4.6.2.3. Limited erosion will take place between the beginning of the processed shale disposal and the completion of revegetation. The implementation of an erosion control plan will reduce the erosion potential (Subsection 4.4.1).

5.5.2.8 Operation Effects on Topography

Disposal of the processed shale will greatly change the topography by covering approximately 3.5 square miles of Southam Canyon to an average thickness of 200 feet. Final grading will produce a 4:1 slope on the face of the shale pile with alternating gentle hills and depressions to collect water during periods of rainfall. By the end of Phases III and IV, the mean elevation of the hills will be 5,800 feet sloping gently to the north.

5.5.2.9 Operation Effects on Subsurface Zones

Commercial production of shale oil will proceed in two stages. During Phase III approximately 80,000 TPCD of shale will be mined for processing. Phase IV will see the production rate doubled and maintained for the life of the project, until the Mahogany zone has been substantially mined out of Tracts U-a and U-b. All mining wil be performed as described in Subsection 3.5.3.1 to minimize surface subsidence. As a result of the removal of the oil shale zone (Mahogany zone) and the placement of processed shale on the surface, increased stress will occur in the geological foundation.

5.5.2.10 Operation Effects on Mineral Resources

The effects produced on existing mineral resources, as listed in Subsection 2.2.6 and excluding oil shale and water, are predicted to be negligible. Sulfur and ammonia will be produced as substantial by-products of the process. Recovery of profitable minerals located near the surface will be difficult in areas where processed shale has been deposited. However, studies indicate that such minerals are probably not present on Tracts U-a and U-b. Deep-lying resources, where present, such as oil and gas, are still recoverable on the lease land.

5.5.2.11 Operation Effects Off Tract

During Phases III and IV, off-tract effects related to soils and geology are ascertained to be negligible since the mining operation and production activities will be confined mainly to the lease land.

Section 5.6

Section 5.6

HISTORIC, PREHISTORIC, AND PALEONTOLOGICAL RESOURCES

The White River Shale Project will affect the historic, archeologic, and paleontological resources of Tracts U-a and U-b. Possible adverse effects include partial or complete destruction of sites by construction and operation activities. Because of existing poor surface conditions, subsurface testing is necessary at one on-tract site to determine its significance. The project will also have the indirect effect of exposing a previously undeveloped area to public vandalism. To prevent such actions now, no maps or specific locational data are included in this report.

5.6.1 PHASE II

Construction of Phase II, the single retort operation, will have little impact on historic, prehistoric, and paleontological resources on the site. In the following paragraphs, the resources are described and the effects evaluated.

5.6.1.1 Construction Impacts on Historic Resources

The only historic structure on the site is an early 20th century cabin on the northwest corner of Section 14. It has no historical or aesthetic value and, in any case, will not be affected directly by Phase II or subsequent construction.

5.6.1.2 Construction Impacts on Prehistoric Resources

There are historic components in some of the archeological sites. The pipeline that will be built from the White River to the water storage tank will pass through Site 372. Collection of surface finds, location recording, and site analysis have already been performed, and no further investigation of this site is recommended.

Six other archeological sites located on tract are unlikely to be directly or indirectly disturbed by any Phase II activity. Those sites adjacent to access roads (409, 408, and 324), however, may be exposed to possible vandalism by virtue of visibility. Since no further study is recommended for Sites 408 and 324, any impact on them would not require mitigation. The potholes in Site 409, a rock shelter, indicate considerable depth of deposit. Test excavation of Site 409 is recommended to determine its significance and to plan mitigation efforts, if necessary.

Site 324, which may be disturbed by widening the access road, and an open site, Site 406, have not been recommended for any further work because they apparently lack subsurface features. Site 373 will be directly affected by the state dam project construction and will be assessed in the EIS prepared for that project; therefore, an evaluation of possible indirect impacts of the White River Shale Project is not necessary.

5.6.1.3 Construction Impacts on Paleontological Resources

In general, the oil shale development will not directly affect significant fossil sites, but two minor paleontological sites will be disturbed by Phase II construction. Site 6, containing unidentifiable fossilized plant debris, is located partially within the proposed water pipeline right-of-way but has been analyzed as insignificant. Site 32, which contains unidentifiable bone fragments of minor significance, may be directly affected by earth-moving activity in the process area.

Site 36, containing insignificant petrified wood from the Uinta Formation, lies in the shale process area and will thus be directly affected by construction of the plant. Site 4, an insignificant site containing unidentifiable plant debris, may be disturbed by widening the access road.

5.6.1.4 Facilities Operation Impacts

Phase II operation will place no further stress on any historic, prehistoric, or paleontological resource on Tracts U-a and U-b.

5.6.2 PHASE III

Phase III construction and operation will have no further impact on historic and prehistoric resources beyond those already identified. Paleontological matter in Site 29, petrified wood from the Uinta Formation, will be directly affected in Phase III operation by disposal of processed shale in Southam Canyon. These fossils are considered of minor significance, and, thus, the impact will be minimal.

5.6.3 PHASE IV

Phase IV construction and operation will have no further impact on historic and prehistoric resources on Tracts U-a and U-b.

The majority of the remaining paleontological sites (Sites 1, 23, 28, 30, and 35) located on Tract U-a will be directly affected by the processed shale disposal. For the most part, the fossils are plant and wood specimens of minor importance. Brontothere fossils found in Site 28 need to be removed to avoid loss during later processed shale disposal activities.

5.6.4 OFF-TRACT IMPACTS

Little or no direct impact will occur in regard to the off-tract sites found during the Baseline survey. The following paragraphs discuss the status of the three types of sites identified.

5.6.4.1 Historic Resources

Within 1 mile of the tracts, there are three additional early 20th century cabins in a state of general disrepair. Since they are considered historically insignificant as a group, they are not evaluated in terms of possible project impact. The only site of historical significance in the immediate area is the Ignacio Stage Stop, located east of State Highway 45.

5.6.4.2 Prehistoric Resources

Approximately 15 of the sites located along the terraces of the White River will be inundated by the proposed state dam project and, therefore, will be the state's responsibility. Sites 401, 118, 368, 369, and 372 may also be affected by the rising pool level caused by the dam. Most of the remaining sites are surface scatters of cultural detritus which were recorded and collected during surface reconnaissance; any direct impacts to these sites will be insignificant.

5.6.4.3 Paleontological Resources

The majority of significant paleontological sites discovered during the survey are located off tract. Brontothere fossils of major significance from the Uinta Formation have been found north of the White River. The fossils are abundant and in good condition and are found ranging through a few hundred feet of strata, which makes them particularly valuable for evolutionary studies. In addition, since previous work on them is incomplete, they are scientifically important for future studies.

Important insect fossil sites have been located adjacent to Tract U-b. None of these, however, will be directly affected by the project.

Section 5.7

Section 5.7

EFFECTS ON AESTHETICS

5.7.1 INTRODUCTION

Changes in aesthetics result from changes in the form, line, color, and texture of the characteristic landscape. These changes are perceived differently, depending on individual reactions to sight, smell, touch, and taste. In project development, one of the design criteria should be to complement rather than deviate from the characteristic landscape.

5.7.2 THE REGIONAL AESTHETIC SETTING

Aesthetic impacts to the three landscape units defined in Section 2.7 are discussed in terms of full-capacity processing (Phase IV). Figure 5.7-1 shows the proposed facilities superimposed on the landscape units. The major project components that will effect the aesthetics are the process facilities, the tank farm, the process shale disposal, the transport systems, the raw shale stockpile, and the onsite reservoirs.

Aesthetic impacts for each landscape unit are summarized in Tables 5.7-1 through 5.7-3 and are rated according to the following system of evaluation (Alden 1973):

+ Positive. Enhancement of the scenic quality of the area, additional diversity to the natural landscape, increase in the field of vision of the foreground and middleground.

o No Significant Change

– Negative. Loss of diversity to the natural landscape and decrease in the field of the foreground and middle-ground; loss of natural color and contour compatibility.

N/A Not Applicable. Change will not occur in the landscape unit being considered.

Impacts to the aesthetic resources will be somewhat reduced by the topography of the site, which offers a natural screening for man-made modifications. Many of the facilities will be contained within local view sheds, which will restrict distant visibility.

5.7.3 THE RIDGETOP-BASIN LANDSCAPE UNIT

Table 5.7-1 shows the extent of impact to the ridgetop-basin unit. Phase II is the single retort operation; Phase III is processing at 50-percent capacity with 14 retorts; and Phase IV is full-scale processing, with 23 retorts. During the decommissioning stage work, programs will be suspended and facilities and improvements will be left intact.

As shown in Figure 5.7-1, most of the project facilities will be located within the ridgetop-basin unit. The major project components affecting the ridgetop-basin complex will be the 23 retorts, the 23 tanks in the tank farm, the processed shale disposal, the transport system, the raw shale stockpile, and the onsite reservoirs.

The process facilities (23 retorts, approximately 160 feet high and 50 feet wide, arranged in linear blocks) will visually interrupt the strongly horizontal line surfaces of the existing ridgetops. On any of the ridges adjacent to the plant site, the process facilities will provide an acute contrast to the surrounding ridgetop-basin landscape. The smooth texture of the facilities will be incompatible with the coursely textured rock forms, vegetation, tree cover, and knolls. Painting these

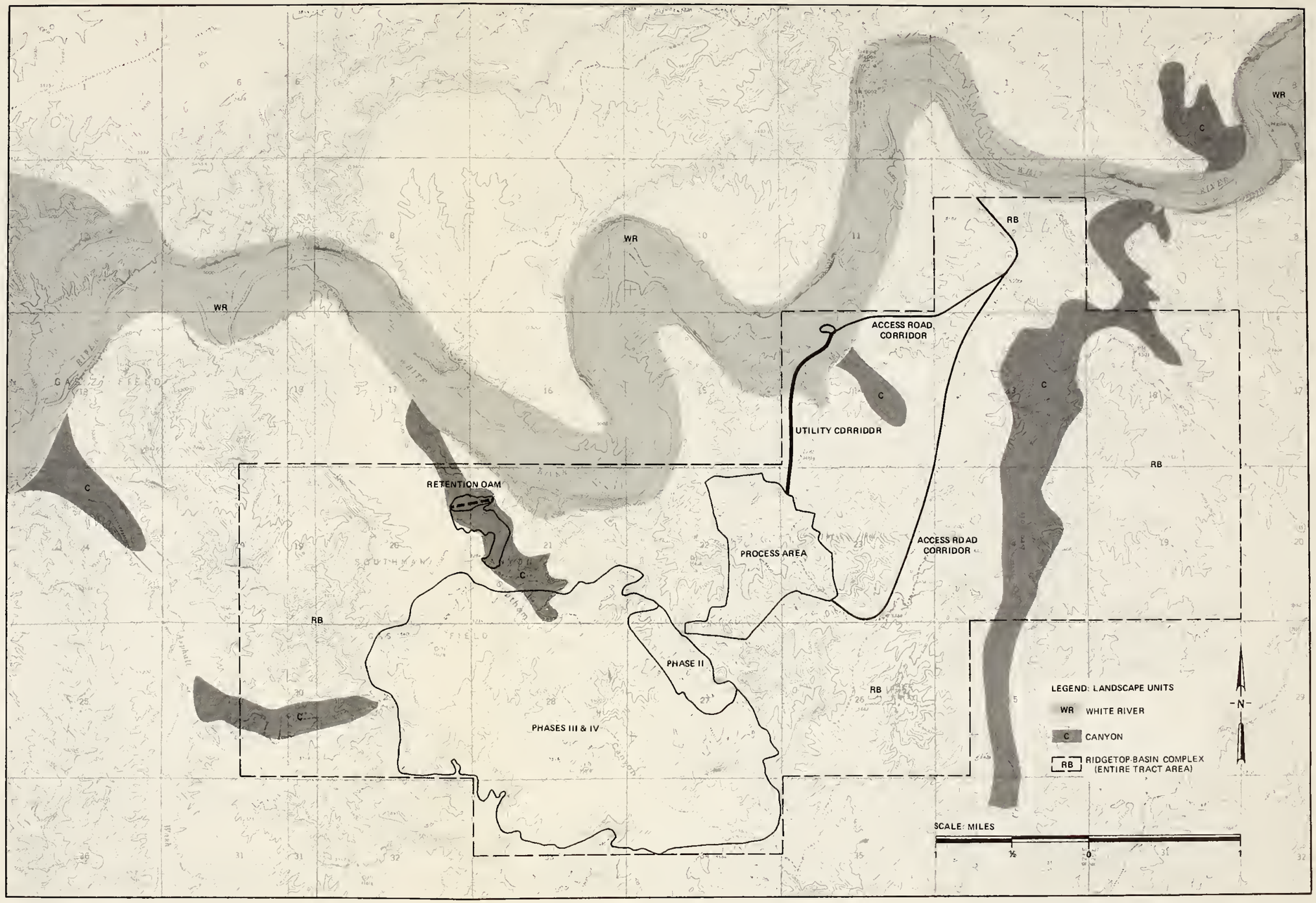


Figure 5.7-1. Landscape Units for Evaluating Aesthetic Resources

Table 5.7-1

AESTHETIC IMPACTS: RIDGETOP-BASIN LANDSCAPE UNIT

	Possible Project Impacts								
	Phase II			Phase III			Phase IV		
	Construction	Operation	Decommissioning	Construction	Operation	Decommissioning	Construction	Operation	Decommissioning/ Abandonment
Land									
Geologic surface material[(a)]	o	o	o	–	–	o	–	–	o
Topographic characteristics (relief)	o	o	o	–	–	–	–	–	o
Air									
Visual and olfactory	o	o	o	o	o	o	–	–	+
Noise	o	o	o	o	o	o	–	–	+
Water									
Appearance	N/A	N/A	N/A	N/A	+	o	N/A	+	o
Land-water interface	N/A	N/A	N/A	N/A	+	o	N/A	+	o
Odor and floating material	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water surface area	N/A	N/A	N/A	N/A	+	o	N/A	+	o
Wooded and geologic shoreline	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Biota									
Domestic animals	o	o	o	–	–	o	–	–	+
Wildlife	o	o	o	–	–	o	–	–	+
Diversity of vegetation	o	o	o	o	–	o	o	–	+
Variation within vegetation types	o	o	o	o	–	o	o	–	+
Man-made objects[(a)]									
Plant facilities	–	–	o	–	–	o	–	–	o
Ancillary facilities	o	o	o	o	o	o	o	o	o
Corridor selection	–	–	o	–	–	o	N/A	–	o
Processed shale disposal	N/A	–	o	N/A	–	o	N/A	–	o

(a) Visual impacts to users of landscape units

facilities in pastel and muted natural colors will reduce this visual impact to some extent; however, in this area the plant will remain a dominant form. Since the retorts and upgrading facilities will be contained mostly within a basin, they will be screened from distant view by the many intervening ridges, as shown in Figure 5.7-1.

The tank farm layout will complement the characteristic land form. The cylindrical tanks will be screened by the rounded and massively blocked landscape setting and will be painted in natural hues to complement the landscape.

The processed shale disposal site will be one of the major impacts on the ridgetop-basin complex. Processed shale will be deposited in Southam Canyon; the shale pile surface will be contoured to a hilly, natural appearance (see Figure 3.10-6), and the pile will reduce a portion of the panoramic views in Southam Canyon. Additional impacts will result from fugitive dust associated with processed shale disposal. The choice of Southam Canyon as the disposal area will reduce the exposure of the waste-material pile within the existing landscape setting.

Construction of access roads, pipeline corridors, and conveyor systems will produce changes over much of the tracts. The access roads will be visible from the ridgetops, even after the decommissioning stage. Construction of these roads will create noise and dust; the construction of the pipelines will have impacts on visual and air quality and will create noise in the area. These impacts will be short-term, since pipeline construction progresses at a rate of approximately 1/2 to 1 mile per day. After construction of the pipeline, a revegetation program will be initiated to reduce any visual residual scar of the utility corridor. Because the transmission lines will use the same utility corridors as the pipelines, land disturbance will be kept to a minimum; however, transmission towers along these corridors will detract from the natural setting.

The conveyors will also detract from the natural setting, although they will be painted muted colors to blend with the existing environment. Certain stretches will be elevated 10 to 30 feet aboveground. Sounds emitted by this system will add to the deterioration of the normal tranquility of this wilderness setting.

The raw shale stockpile for the secondary crushers will be over 100 feet high, approximately 1,200 feet long, and will be situated against a ridge that ranges in height from approximately 50 to 70 feet. The stockpile will be easily visible from some of the ridges in the plant area and will detract from the natural form, line, and texture of the existing environment. Its color will not detract significantly from the background.

Construction of the reservoirs will cause dust, noise, and visual impacts on the immediate process area; however, when these reservoirs are filled with water, they will introduce diversity into the landscape unit. After decommissioning of the operations, the water in these reservoirs will evaporate. Vegetation in these areas will eventually reestablish naturally.

5.7.4 THE CANYON LANDSCAPE UNIT

Construction and subsequent use of the Southam Canyon retention dam and the processed shale pile will affect the canyon landscape unit. The extent of the effects is summarized in Table 5.7-2.

The impoundment structure will differ from the characteristic landscape by its artificial appearance. The processed shale pile in Southam Canyon will destroy a portion of the views that are characteristic of this landscape unit.

Table 5.7-2

AESTHETIC IMPACTS: CANYON LANDSCAPE UNIT

	Possible Project Impacts								
	Phase II			Phase III			Phase IV		
	Construction	Operation	Decommissioning	Construction	Operation	Decommissioning	Construction	Operation	Decommissioning/ Abandonment
Land									
Geologic surface material[a]	N/A	N/A	N/A	–	–	–	o	–	–
Topographic characteristics (relief)	N/A	N/A	N/A	–	–	–	o	–	–
Air									
Visual and olfactory	N/A	N/A	N/A	–	–	o	o	–	+
Noise	N/A	N/A	N/A	–	–	o	o	–	+
Water									
Appearance	N/A	N/A	N/A	N/A	–	–	N/A	–	–
Land-water interface	N/A	N/A	N/A	N/A	–	–	N/A	–	–
Odor and floating material	N/A	N/A	N/A	N/A	–	–	N/A	–	–
Water surface area	N/A	N/A	N/A	N/A	–	–	N/A	–	–
Wooded and geologic shoreline	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Biota									
Domestic animals	N/A	N/A	N/A	–	–	o	N/A	–	+
Wildlife	N/A	N/A	N/A	–	–	o	N/A	–	+
Diversity of vegetation	N/A	N/A	N/A	–	–	o	N/A	–	+
Variation within vegetation types	N/A	N/A	N/A	–	–	o	N/A	–	+
Man-made objects[a]									
Plant facilities	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ancillary facilities	N/A	N/A	N/A	–	–	o	–	–	o
Corridor selection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Processed shale disposal	N/A	N/A	N/A	N/A	–	N/A	–	–	–

(a) Visual impacts to users of landscape units

5.7.5 THE WHITE RIVER LANDSCAPE UNIT

Impacts on the White River landscape unit will result primarily from construction of the pipeline corridors and pump station on the White River. The extent of these impacts is summarized in Table 5.7-3. The pump station will have a visual impact only during construction; afterwards it will be painted a neutral color consistent with the natural colors of the landscape unit. During operation of the state dam, the pump station will be submerged.

Recreational users of the White River and the state reservoir will have an unobstructed view of the processed shale disposal site and most of the retorts, flares, stacks, and fractionation columns. Figure 3.10-6 is an artist's conception of the disposal site. During construction of the processed shale pile, the visual impact of its deviation from the characteristic landscape will be increased by fugitive dust.

5.7.6 SUMMARY

The majority of intrusive visual, olfactory, and noise factors associated with the White River Shale Project are localized within the ridgetop-basin and canyon units. Many of the facilities and land modifications of the White River Shale Project will be seen only from on-tract access roads, from vantage points on the adjacent ridges, or from the air. The natural topography of the landscape units is well suited to absorb, or locally contain and subordinate, the alterations to the land to be caused by the project. The White River Canyon, which is the most recreationally used unit, will be affected by only two major project components — the stacks from the process plant and the processed shale pile. The pump station, which will have a visual impact during the construction stage, will be submerged in the White River during the operation of the state dam; thus, its impact will be short-term.

Table 5.7-3

AESTHETIC IMPACTS: WHITE RIVER LANDSCAPE UNIT

	Possible Project Impacts								
	Phase II			Phase III			Phase IV		
	Construction	Operation	Decommissioning	Construction	Operation	Decommissioning	Construction	Operation	Decommissioning/ Abandonment
Land									
Geologic surface material[a]	–	–	o	–	–	o	N/A	–	o
Topographic characteristics (relief)	–	–	o	–	–	o	–	–	+
Air									
Visual and olfactory	–	–	o	–	–	o	–	–	+
Noise	o	o	o	o	o	o	o	o	o
Water									
Appearence	–	o	o	–	o	o	o	o	–
Land-water interface	–	–	o	–	–	–	N/A	–	+
Odor and floating material	o	o	o	o	o	o	o	o	o
Water surface area	o	o	o	o	o	o	o	o	o
Wooded and geologic shoreline	–	o	o	–	o	o	o	o	+
Biota									
Domestic animals	–	–	o	–	–	–	–	–	+
Wildlife	–	–	o	–	–	–	–	–	+
Diversity of vegetation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
variation within vegetation types	–	–	o	–	–	o	–	–	+
Man-made objects[a]									
Plant facilities	–	–	o	–	–	o	–	–	+
Ancillary facilities	–	–	o	–	–	o	N/A	N/A	+
Corridor selection	–	–	o	–	–	o	N/A	N/A	+
Processed shale disposal	N/A	–	o	N/A	–	+	N/A	–	+

(a) Visual impacts to users of landscape units

Section 5.8

Section 5.8

ENVIRONMENTAL EFFECTS OF DECOMMISSIOING-ABANDONMENT

Plans for decommissioning or abandonment of White River Shale Project facilities are discussed in Section 3.21. Decommissioning refers to suspension of work programs without dismantling or destruction of improvements. Abandonment refers to relinquishment or termination of the lease and disposition of improvements.

5.8.1 DECOMMISSIONING

5.8.1.1 Decommissioning of Mine

In decommissioning, mine equipment will be mothballed and stored. Mine structures will be inspected periodically and maintained. Consequently, the facility will be available for the resumption of operations when needed.

Pumping of the mine will be continued as required to control water. The water from the mine will be discharged to the stormwater holding basin.

5.8.1.2 Decommissioning of Aboveground Facilities

In decommissioning, aboveground facilities used during Phase II operations will be maintained for future use. Catalysts and chemicals will be either stored or disposed of. Treatment of surface runoff will continue, if necessary, to prevent development of a standing pond of objectionable water in the catchment basin.

Existing revegetated areas will be maintained. Areas that will not be affected by construction activities for Phases III and IV operation will be revegetated.

5.8.2 ABANDONMENT

5.8.2.1 Abandonment of Mine

If the mine is abandoned after the presently leased resource is exhausted, economically salvageable equipment will be removed. The mine shafts and portals will be sealed to remove the hazards to man and animals.

5.8.2.2 Abandonment of Aboveground Facilities

In abandonment, economically salvageable equipment and materials will be removed. Surface structures will be taken down to grade. The land will not be returned to its original contours, but disturbed areas will be rehabilitated to bring them to a usable and productive conditions in compliance with lease requirements.

Safe access to permanent impoundments will be provided for wildlife, livestock, and man. If consumption of some impounded waters would be detrimental to man or animal, access will be prevented by construction of permanent barriers.

Revegetation of the processed shale disposal area and maintenance of revegetated areas will be continued for a reasonable period of time.

PART 6

Section 6.1

Section 6.1

OBJECTIVES AND RATIONALE OF THE MONITORING PROGRAM

As described in the Oil Shale Lease Environmental Stipulations (Ref. 1), the monitoring program has several purposes:

- To record the changes that have taken place since the beginning of development operations
- To continuously check compliance with the provisions of the lease and the Environmental Stipulations
- To check compliance with all applicable federal, state, and local environmental protection and pollution control requirements
- To provide a timely notice of detrimental effects and conditions requiring correction
- To furnish a factual basis for revising or amending the Environmental Stipulations, as provided for in Section 1 (B) thereof

The intent of the Environmental Baseline Survey (Ref. 7) has been to compile data of sufficient quality and quantity to allow a characterization of conditions existing before the start of development operations. By monitoring selected parameters identified during the baseline program as being reliable indicators of base conditions, it is possible to detect changes that may occur during the life of the project. The duration of the monitoring program will adhere to the requirements of the Environmental Stipulations (Ref. 1).

The monitoring plan as presented herein is coordinated with the most probable schedule for facility development as shown in Figure 1.2-2. The monitoring program described in this section will be instigated at least 6 months prior to start of construction.

Section 6.2

Section 6.2

AIR MONITORING

During Phases II, III, and IV, gaseous and particulate pollutants will be generated and emitted to the atmosphere, but these will be regulated by pollution control devices. An ongoing meteorological and air quality monitoring program will be conducted to monitor emissions relative to emission standards and ambient air quality standards.

After the baseline data collection program is completed, the air monitoring station at A6 will remain in operation. Table 6.2-1 shows the schedule of operation for the monitoring stations. Stations A2, A4, A11, and A13 will be reactivated at least three months before the start of the major construction activities of Phase II, as shown in Table 6.2-2. This will allow sufficient time to substantiate baseline air quality data at the various stations before monitoring the effect of construction and operation.

Stations A3 and A7 will be reactivated prior to the operation of Phase III, as shown in Table 6.2-3. Once reactivated, the stations operating during Phase III and IV will remain in operation until deactivation is agreed on by the White River Shale Project and the Area Oil Shale Supervisor.

In addition to the meteorological and ambient air quality sampling stations, source sampling access ports will be located at all points of possible significant pollutant emissions to the atmosphere. These ports will provide access for emission source testing equipment to demonstrate compliance with emission standards. This data will also be used during Phases II and III to update and validate atmospheric model results in regard to expected ground level concentrations of emissions from future phases of the project.

Table 6.2-1

SCHEDULE OF OPERATION FOR THE MONITORING STATIONS

Post Baseline	3 Months Prior to Phase I Construction	Phase I Operation	Phase II Operation	Phase III & IV Operation
A-6	Meteorology, Particulates SO_2, NO_x, Hydrocarbons, CO, Oxidants	Continued	Continued	Continued
A-2	Meteorology, Particulates	Continued	Continued	Continued
A-4	Meteorology	Continued	Continued	Continued
A-11	Meteorology, Particulates	Continued	Continued	Continued
A-13	Meteorology	Continued	Continued	Continued
A-3				Meteorology, Particulates, SO_2, NO_x Hydrocarbons, CO
A-7				Meteorology Particulates, SO_2

6.2.1 PARAMETERS AND MONITORING METHODOLOGY

Tables 6.2-1, 6.2-2 and 6.2-3 list the parameters to be measured and the frequency of the sampling periods at the various sites. Table 6.2-4 lists the equipment that will be used to monitor these parameters. The locations of these monitoring stations are shown in Figure 6.2-1.

All instruments will be calibrated at least once every 3 months to ensure their continuing accuracy. In addition, as data are being extracted from the analog records, they will be scanned for anomalous readings. In the monitoring program, all instruments will be inspected in situ at least twice a week, and a record will be kept of maintenance and of any malfunctions. Corrective actions will be logged.

Analog recording charts will be changed at various time intervals, depending on the length of each chart roll. Time checks will be inscribed

Table 6.2-2

THE FREQUENCY WITH WHICH METEOROLOGICAL AND AIR QUALITY PARAMETERS ARE MONITORED AT VARIOUS STATIONS DURING PHASE II

	Monitoring Stations[a]				
	A2	A4	A6	A11	A13
Wind Speed	C	C	C	C	C
Wind Direction	C	C	C	C	C
Wind Variance			C		
Temperature	C	C	C	C	C
Lapse Rate			C		
Dew Point			C		
Suspended Particulates	A		A	A	
Sulfur Dioxide			C		
Nitrogen Oxides			C		
Hydrocarbons			C		
Carbon Monoxide			C		
Oxidants			C		

C = Continuous
A = One 24-hour sample each 6 calendar days

(a) See Figure 6.2-1 for the locations.

Table 6.2-3

THE FREQUENCY WITH WHICH METEOROLOGICAL AND AIR QUALITY PARAMETERS ARE MONITORED AT VARIOUS STATIONS DURING PHASES III AND IV

	Monitoring Stations[a]						
	A2	A3	A4	A6	A7	A11	A13
Wind Speed	C	C	C	C	C	C	C
Wind Direction	C	C	C	C	C	C	C
Wind Variance				C			
Temperature	C		C	C		C	C
Lapse Rate				C			
Dew Point				C			
Suspended Particulates	B	A		B	A	B	
Sulfur Dioxide		C		C	C	C	
Nitrogen Oxides		C		C			
Hydrocarbons		C		C			
Carbon Monoxide		C		C			
Oxidants				C			

C = Continuous
B = One 24-hour sample every day
A = One 24-hour sample each 6 calendar days

(a) See Figure 6.2-1 for the locations of the monitoring stations.

Table 6.2-4

PROPOSED MONITORING EQUIPMENT

Wind Speed and Direction,	MRI Model 1022	A-6 (10 and 30M) A-3 (10M) A-7 (10M) A-11 (10M)
Wind Speed, Direction, and Temperature	MRI Model 1071 Mechanical Weather Station	A-2, A-4, A-13
Wind Variance	MRI Model 1022/R. M. Young and AeroVironment Sigma Meter	A-6 (30M)
Temperature and Lapse Rate	MRI Thermistors w/R. M. Young Shield	A-6 (10 and 30M)
Dew Point	EG&G Model 880 Hygrometer	A-6
Suspended Particulates	General Metals Model 5000 HiVol Constant Flow Control	A-2, A-3, A-6, A-11
Sulfur Dioxide	Tracor 270 HA Sulfur Analyzer-Gas Chromatography	A3, A6, A7, A11
Nitrogen Oxides	Monitor Labs Model 8440 NO_x Analyzer Chemiluminescence	A-3, A-6
Hydrocarbons	Beckman 6800 Gas Chromatograph, Flame Ionization	A-3, A6
Carbon Monoxide	Beckman, 6800 Gas Chromatograph, Flame Ionization	A-3, A6
Oxidants	Monitor Labs 8410, Ozone Analyzer, Photoluminescence	A-3, A6
Precipitation	Fisher-Porter automatic Rain gage, series 35 B 1558	P1, A8, Plant Site, S9, A2, S12

on each chart roll at the time of each visual inspection to ensure that the charts are running at proper speed and that the recording trace is normal. Chart rolls will be packaged and mailed for data reduction and recording after they have been removed from the recording instruments. To prevent data loss, the paper tape from the data logging system will be mailed separately for processing. High-volume air sampler filters will be changed according to individual preset sampling schedules, and the exposed filters mailed individually for laboratory processing.

6.2.2 RATIONALE

The choice of sampling equipment is based on expected emission levels, instrument reliability and sensitivity levels, precision of analytical methods, computer compatibility, and applicability to sampling periods required by federal and state standards. The choice of sampling periods is based on federal and state requirements for data reporting frequency. The location of sampling stations on or near the tracts is determined by the proposed locations of project facilities, local meteorological conditions, and expected points of maximum pollutant concentrations. Because of the variable geometries of the sources, the points of maximum concentrations vary substantially by pollutant but are generally east of the process area. Other secondary maximum concentration points are generally north and south of the process area. The proposed sampling sites were chosen to monitor air quality in the vicinity of these expected maximum concentration points.

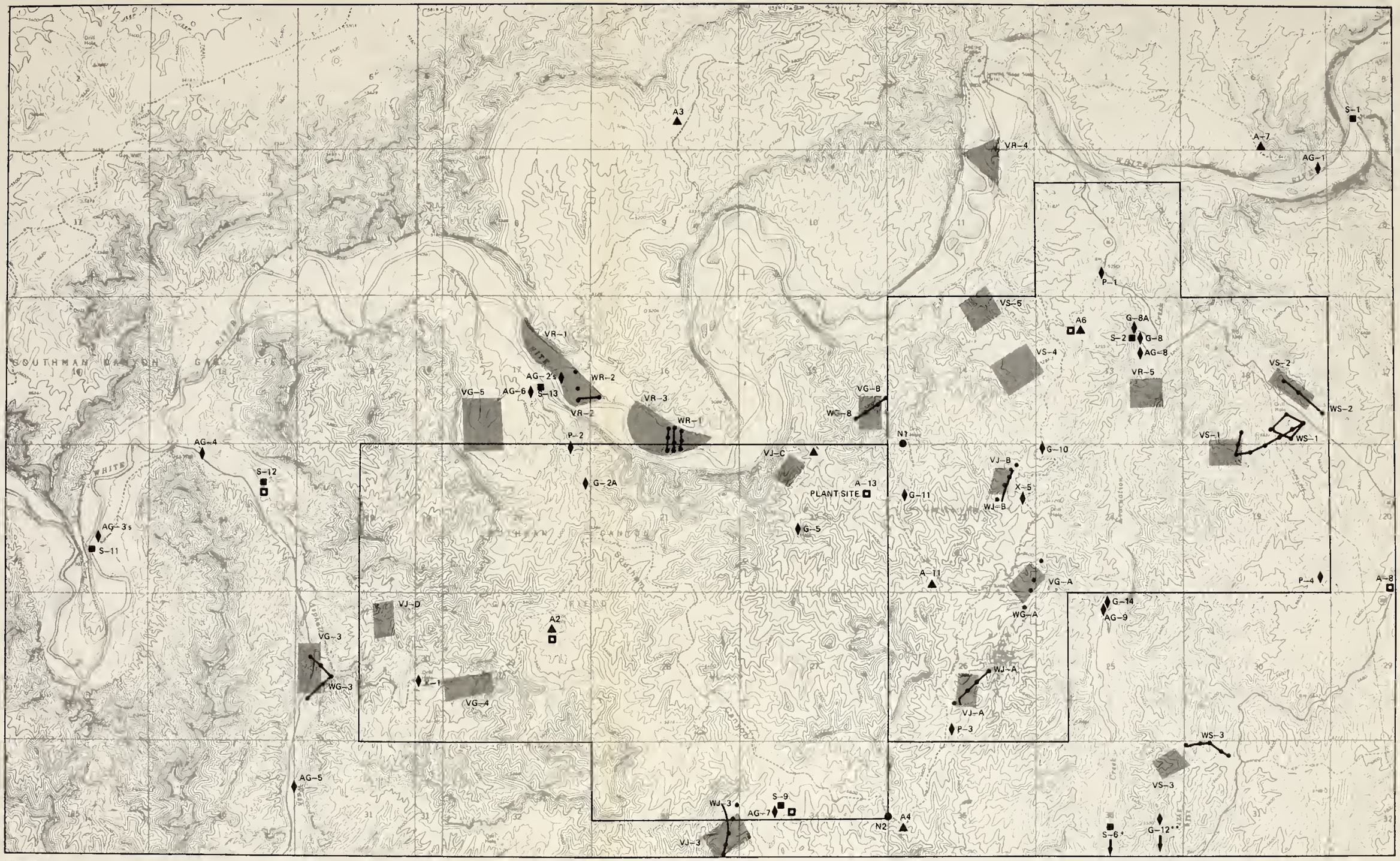
6.2.3 DATA HANDLING

Air monitoring data at the facilities will be recorded on both punched paper tape and analog strip charts. (The strip charts provide data recording redundancy – that is, they are used as backup if there is any failure in the punched paper tape system.) These data will be sent to the data handling facility where they will be logged and cataloged.

At the data handling facility, the first step after cataloging will be to examine the analog charts for discontinuities and anomalies in the data. If this examination reveals neither discontinuities nor anomalies, the data will be extracted from the paper tapes and reduced to appropriate average values, and any data missing from the tapes will extracted from the backup strip charts.

At this point, the data will be analyzed by computer methods directly from the paper tape record or (where necessary) from punched cards based on the analog data. Next, the data will be tabulated, and the tabulation units will be consistent with the pertinent standards, i.e., 3-hour, annual average. Maxima will also be reported. Computer processing of data will allow for the generation of pollutant concentration contours at the sites.

A report covering all phases of the air monitoring program will be prepared to be submitted annually to the Area Oil Shale Supervisor. Data will be presented in tables or graphs and summarized with appropriate texts. Notices of unusual or deviant trends will be sent to the Area Oil Shale Supervisor prior to the annual issuance of the report. All records will be kept current at the offices of the White River Shale Project.



LEGEND

- ▲ AIR MONITORING AND METEOROLOGICAL STATIONS (A)
- ● NOISE MONITORING STATIONS (N)
- ■ SURFACE WATER MONITORING STATIONS (S)
- ♦ GROUNDWATER MONITORING STATIONS
- ◘ PRECIPITATION MONITORING STATIONS

V = VEGETATION STUDY SITES
G = SAGEBRUSH - GREASEWOOD
J = JUNIPER
S = SHADSCALE
R = RIPARIAN

X = EXPLORATORY GEOLOGIC CORE HOLE
AG = ALLUVIAL WELL
P = PUMP TEST WELL
G = GROUNDWATER MONITORING WELL

W = WILDLIFE TRANSECTS

A, B, C, O = PROPOSED NEW VEGETATION STUDY SITES OR WILDLIFE TRANSECTS

NUMBERS = EXISTING BASELINE STUDY SITES AND WILDLIFE TRANSECTS

*S-6 Approximately two miles south of tract limit
**G-12 Approximately one mile south of tract limit

Figure 6.2-1. Monitoring Program Sampling Stations

Section 6.3

Section 6.3

WATER MONITORING

The water monitoring program described here is based on requirements of the Oil Shale Lease, on the available results of the Environmental Baseline Survey (Ref. 7), and on preliminary chemical analysis of representative processed oil shales. The rationale for the program is presented in Subsections 6.3.1.2 and 6.3.2.2. The program will be implemented after the Environmental Baseline Survey (Ref. 70) is completed and will continue until Phase II has been under way for approximately 18 months. The program will be then reassessed on the basis of expected future development activities, and analysis of Utah processed shale and processed shale leachate.

6.3.1 SURFACE WATER

Continuous or intermittent sampling for chemical and physical constituents will be carried out at selected stations in order to monitor environmental water quality during development and operation of the mining and processing facilities.

6.3.1.1 Parameters and Methodology

Streamflow Gauging Stations. Continuous streamflow records will be collected at the following stations (Figure 6.2-1):

S-1 The White River at its confluence with Hells Hole Canyon, upstream from the tract in the anticipated reservoir pool

S-2 Evacuation Creek on Tract U-b

S-6 Evacuation Creek upstream from Tract U-b

S-9 Southam Canyon at the south boundary of Tract U-a

S-11 White River below the proposed river dam site

S-12 Asphalt Wash approximately 3,000 feet upstream from from its confluence with the White River

S-13 Southam Canyon just above its junction with the White River

Stations S-9, S-12, and S-13 are expected to have zero flow during most of the year and will be monitored by manual sampling, as necessary.

Water Quality Monitoring. Two water quality parameters — temperature and specific conductance — will be monitored continuously and automatically at all seven streamflow gauging stations listed above.

During high flow periods, which generally occur during snowmelt in March through May, continuous measurements will be supplemented by daily measurements during flood periods of suspended and total dissolved solids at Station S-11. Daily sampling will be carried out only during flood periods and will be discontinued after peak flows have passed.

Water samples will be collected monthly at four stations (S-1, S-2, S-6, and S-11) and analyzed for the water quality parameters listed in Table 6.3-1. At Stations S-9, S-12, and S-13 (Southam Canyon) sampling frequency will coincide with periods of heavy runoff. As few as two to three samples per year may be obtainable, and these will be analyzed for the parameters listed in Table 6.3-1.

Water quality will also be monitored in the Southam Canyon runoff retention pond downgrade from the processed shale disposal area. Monitoring will be carried out when there is standing water. Water depth in the pond will be measured quarterly by plumb line in the deepest area; a marker buoy will be provided for this purpose, if

Table 6.3-1

PARAMETERS FOR SURFACE WATER QUALITY
MONITORING TRACTS U-a AND U-b

Arsenic	Mercury	Specific conductance
Boron	Molybdenum	Sulfate
Calcium	pH	Suspended solids
Chloride	Potassium	Temperature
Dissolved Oxygen	Selenium	Total alkalinity
Fluoride	Silica	Total carbon
Magnesium	Sodium	Total dissolved solids
		Total organic carbon

necessary. A permanent depth gauge will be mounted on the retention pond dam for reference, or an automatic water level recorder may be installed. In addition, whenever a new pond forms, a water sample will be collected quarterly, if necessary, and analyzed for the constituents and properties listed in Table 6.3-1. If it becomes apparent that water quality in this pond is variable, sampling frequency can be performed monthly. Similarly, if the water level fluctuates markedly, the depth of the pond will be monitored monthly or continuously.

Precipitation will be monitored by automatic recorders at P-1, A-8, Plant Site, S-9, A-2, and S-12 as shown in Figure 6.2-1.

All surface water samples will be collected using standard field equipment and sampling techniques. All parameters will be determined according to procedures detailed in Standard Methods for the Examination of Water and Wastewater, (Ref. 57), or according to methods approved by the Area Oil Shale Supervisor, where appropriate.

6.3.1.2 Rationale

Streamflow Gauging Stations. The seven surface water gauging station locations were selected to ensure that surface water movement on or near Tracts U-a and U-b will be monitored. Station numbers and locations

are identical to those of the Baseline Survey. Two stations on the White River have been selected: one upstream (S-1) and one downstream (S-11) from the oil shale tracts and the anticipated White River Dam site. The two stations in Southam Canyon are located upgrade (S-9) and downgrade (S-13) from the proposed processed shale disposal area. If Station S-9 is threatened with burial under processed shale, it will be relocated at an adequate distance upgrade and, if necessary, off tract. Station S-12 in Asphalt Wash is recommended because the latter drains the western portion of Tract U-a. Two stations on Evacuation Creek have been selected: one upstream (S-6) and one downstream (S-2) from the areas of major activity.

Water Quality Monitoring. According to available chemical analyses of typical processed shales, six of the recommended water quality parameters (arsenic, boron, fluoride, mercury, molybdenum, and selenium) are potential trace constituents in processed oil shale. The other parameters listed in Table 6.3-1 are basic indicators of water quality and, in some cases, major soluble constituents of processed shale. Specific conductance will be monitored continuously; the measurement is simple and rapid and an indicator of changes in total dissolved salts concentration. Continuous temperature measurements are necessary to calibrate specific conductance readings.

Since the bulk of transport occurs during peak flow periods, supplementary measurements of suspended solids and total dissolved solids will be carried out whenever practical during these periods.

The Southam Canyon runoff retention pond will be monitored because surface water in this area is likely to contain soluble salts leached from the processed shale pile. The combined surface water and groundwater monitoring program in Southam Canyon will provide a means for identifying and tracking any pollutants from the processed shale pile.

6.3.1.3 Data Treatment

A report covering all phases of the water monitoring program will be prepared and submitted annually to the Area Oil Shale Supervisor. Each report will contain all data gathered during the year. Data will be presented in tabular or graphical form, as appropriate, and summarized with appropriate text. The Area Oil Shale Supervisor will receive timely notice of unusual or deviant data or data trends prior to the issuance of the annual report, and such data will be discussed in the text of the report. All records will be kept current at the WRSP offices.

For all water samples, analytical data will be expressed as recommended in Ref. 57. Solute concentrations will be reported in milligrams per liter (mg/l) or micrograms per liter (μg/l) and flow rates will be reported in cubic meters per second (cms) and in cubic feet per second (cfs). All data will be recorded on punched tape or cards or other suitable method and held in a central repository for later use in statistical analysis.

6.3.2 GROUNDWATER

Semiannual monitoring of groundwater quality for the Bird's Nest Aquifer, quarterly monitoring of groundwater quality of the alluvial aquifer, and quarterly measurements for depth to water will be initiated at selected stations.

6.3.2.1 Parameters and Methodology.

Groundwater quality will be monitored every quarter in alluvial wells (if water is present) and semiannually in wells penetrating the Bird's Nest Aquifer. The station numbers corresponding to these wells are listed in Table 6.3-2 and shown in Figure 6.2-1.

In addition, the stations given in Table 6.3-3 will be used to monitor depth to water. For uniformity, water levels will be measured and recorded within 1 week of the beginning of each quarter. Depth-to-water

Table 6.3-2

DEPTH AND LOCATION OF WELLS WHERE GROUNDWATER QUALITY WILL BE MONITORED

Site Number	Depth (ft)	Aquifer	Location
AG-1 Upper U	12	Alluvial	White River Channel NE 1/4 12 T10S R24E
Lower U	44	Alluvial	White River Channel NE 1/4 12 T10S R24E
AG-2 Upper D	21	Alluvial	White River Channel SE 1/4 12 T10S R24E
Lower D	40	Alluvial	White River Channel SE 1/4 17 T10S R24E
AG-3 Upper D	20	Alluvial	White River Channel SE 1/4 23 T10S R23E
Lower D	38	Alluvial	White River Channel SE 1/4 23 T10S R23E
AG-6 D	27	Alluvial	Southam Canyon SE 1/4 17 T10S R24E
AG-7 U	37	Alluvial	Southam Canyon NW 1/4 34 T10S R24E
AG-8 U	20	Alluvial	Evacuation Creek NE 1/4 13 T10S R24E
AG-9 U	20	Alluvial	Evacuation Creek NW 1/4 25 T10S R24E
G-2A D	41	Alluvial	Southam Canyon NE 1/4 20 T10S R24E
P-2 Upper D	378	Bird's Nest	NE 1/4 20 T10S R24E
Lower D	519	Bird's Nest	NE 1/4 20 T10S R24E
P-3 U	540	Bird's Next	SW 1/4 26 T10S R24E
G-11 U	650	Bird's Nest	NW 1/4 23 T10S R24E
G-21 D	611	Bird's Nest	NW 1/4 29 T10S R24E

U = upgradient from processed shale deposit

D = downgradient from processed shale deposit

measurements for each well will be made using a steel-tape, electric probe or a continuous water level recorder. The wells to be used only for monitoring depth to water are listed in Table 6.3-3 and shown in Figure 6.2-1.

The value of the parameters listed in Table 6.3-4 will be determined on samples collected for chemical analysis. Water sample collection and treatment will follow methods described in "Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases", Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5 (1970) (Ref. 58).

Chemical procedures for the analysis of water samples for various constituents will be those listed in Standard Methods for the Examination of Water and Wastewater, 13th Edition (1971) (Ref. 57) or, where appropriate, according to methods approved by the Area Oil Shale Supervisor. Anticipated collection dates for a semiannual program of groundwater sampling are during May-June and November-December. Additional collection dates suggested for the quarterly sampling program are during February-March and August-September. Water samples will be collected from each well using a pump or, in the case of small diameter wells, a boiler or thief sampler.

As part of the continuation of the groundwater monitoring program into the commercial operation phases, a series of shallow alluvial test wells will be maintained near the foot of the processed shale pile. This test program will provide information on any shallow aquifer contamination as rapidly as is practicable. As the edge of the pile approaches a well site, it will be abandoned and a new well prepared at an appropriate distance downgradient. The total number of sequential wells required during the life of the project will be determined, in consultation with the AOSO, after the program is underway.

Table 6.3-3

DEPTH AND LOCATION OF WELLS WHERE
DEPTH TO WATER WILL BE MONITORED

Site No.	Depth (ft)	Aquifer	Location
P-1	488	Bird's Nest	SW 1/4 12 T10S R24E
P-4	400	Douglas Creek	SE 1/4 19 T10S R24E
X-5	936	Bird's Nest	NE 1/4 23 T10S R24E
G-5	620	Bird's Nest	SW 1/4 22 T10S R24E
G-8A	100	Bird's Nest	NE 1/4 13 T10S R24E
G-8	127	Bird's Nest	NE 1/4 13 T10S R24E
G-10	400	Bird's Nest	NW 1/4 24 T10S R24E
G-12	100	Bird's Nest	SE 1/4 36 T10S R24E
G-14	90	Bird's Nest	NW 1/4 25 T10S R24E

Table 6.3-4

PARAMETERS FOR QUARTERLY AND SEMIANNUAL
GROUNDWATER QUALITY MONITORING ON TRACTS U-a AND U-b

Arsenic	Molybdenum	Sulfate
Boron	pH	Sulfide
Calcium	Potassium	Total dissolved solids
Chloride	Selenium	Total organic carbon
Fluoride	Silica	Temperature
Magnesium	Sodium	Total alkalinity
Mercury	Specific conductance	Total carbon

6.3.2.2 Rationale

Water quality stations were selected to provide information on water-bearing zones upgradient and downgradient from the proposed processed shale disposal area, as required by the Oil Shale Lease. At Stations AG-1, AG-2, and AG-3, an additional alluvial well was drilled to a depth 5 feet below the standing water level, as designated by the Area Oil Shale Supervisor. The parameters in Table 6.3-4 were chosen because they are basic indicators of either water quality or potential contaminants from the processed shale. Water level fluctuations will be monitored to determine changes in groundwater storage and flow direction.

6.3.2.3 Data Treatment

Chemical data collected will be tabulated and contoured in units of milligrams per liter (mg/l) on an annual basis to detect possible groundwater quality degradation with time that may result from mining operations. All data collected on depth to water will be graphed quarterly and presented as water elevation contours in the annual report.

Anomalous data or data trends will be brought to the attention of the Area Oil Shale Supervisor in a timely manner and discussed in the annual report. All data will be submitted to a permanent project record in punched tape, card format, or other suitable method to make them available for future statistical analysis.

6.3.3 SURFACE SUBSIDENCE FROM MINING

Subsidence as a result of mining is not an uncommon occurrence above a mined area. Rock samples taken from the core of the drill holes on U-a and U-b indicate that the mine will have a safety factor of about 2.5 when mining some 70 percent of the ore zone, consequently, surface subsidence on the tracts should be negligible.

6.3.3.1 Monitoring

Two lines of surveyed stations will be established on the surface overlying the initial mine area. These lines will be perpendicular to each other and oriented in the same direction as the mine entries. They will be set and measured before Phase II mining begins and will be measured periodically for elevation to determine if subsidence is taking place.

Initial measurements will be at least semiannually but the frequency of measurement and number of measuring stations may be easily increased if it is necessary.

6.3.3.2 Data Tabulation

The surveyed elevation data will be tabulated and cross-sections plotted to show any subsidence taking place and its relation to the mining activities.

Section 6.4

Section 6.4

SOLID WASTES MONITORING

The solid wastes monitoring plan is based on requirements of the Oil Shale Lease and of the Utah State Code of Solid Waste Disposal Regulations, which are summarized in Section 7 of the Summary of Environmental Regulations and Guidelines (Ref. 46). The solid waste disposal plan, including waste sources, types, and quantities expected during the single retort operation phase and the commercial operation phases, is described in Section 5.3. All solid wastes will be deposited in the processed shale disposal area, some uniformly mixed in processed shale, and some layered in processed shale.

6.4.1 PARAMETERS AND MONITORING METHODOLOGY

Records of disposed wastes will be kept. The record will include types, and approximate quantities of solid wastes; the disposal area being employed; and special provisions used for chemical waste disposal.

During commercial operation, wastes from Phases III and IV will be inventoried as to types and quantities and then will be mixed with the processed shale for disposal. In addition, a regular program of inspection will be established to ensure that collection, storage, transport, and disposal practices are being carried out in a safe and environmentally acceptable manner.

In the implementation of the water monitoring program outlined in Section 6.3, surface water and groundwater quality data will be collected that will also be used to assess the changes, if any, in surface water or groundwater quality attributable to solid waste disposal practices.

Samples collected at the streamflow gauging stations (S-9, S-13) and analyzed for the parameters listed in Table 6.3-1 will provide data to evaluate surface water quality upgradient and downgradient from the solid waste disposal sites in the processed shale disposal area. In addition, any runoff or leachate collected from the initial solid waste landfilling operations (during construction and before deposition of processed shale) will be sampled semiannually and analyzed for the parameters listed in Table 6.3-1. This activity will be supplanted by monitoring the water quality in the Southam Canyon runoff retention pond when processed shale and other solid wastes are being deposited.

Groundwater sampling stations listed in Subsection 6.3.2.1 will be located in the water-bearing zones both upgradient (P-3, G-11) and downgradient (P-2, G-2A, AG-6, G-21) from the processed shale disposal area, which includes the solid waste disposal area. The groundwater sampling and analysis program will provide information to assess water quality changes that might result from processed shale and solid waste disposal operations.

Air quality monitoring plans (Section 6.2) associated with processed shale disposal will include monitoring in the solid waste disposal area. The initial solid waste landfill will contain a small amount of decomposable wastes. Although gas evolution is not expected to be detectable over the life of the lease, the site will be checked regularly for gas emissions through the use of a hand-held hydrocarbon sensor. If detected, the gases will be sampled and analyzed to determine whether control measures, such as vents or barriers, are warranted.

6.4.2 RATIONALE

The solid wastes monitoring program is designed to comply with applicable federal and state regulations and to provide assurance that disposal practices are safe and environmentally acceptable. In addition, the monitoring data collection program is intended to furnish information from which the environmental impacts of the waste disposal operations and the need for implementation of additional mitigating measures can be assessed.

6.4.3 DATA HANDLING

The reporting procedure, format, content, and frequency of the reports will be subject to the requirements of the Area Oil Shale Supervisor and of the Utah State Division of Health.

An annual report will be submitted to the Area Oil Shale Supervisor and the Utah State Division of Health. The report will contain a narrative summarizing the waste disposal operations, the location of the disposal site(s), and any major problems or difficulties. Types, and approximate quantities of solid wastes disposed of during the reporting period will be presented in tabular form. Water and air quality monitoring data pertinent to solid waste disposal activities will be tabulated and appended to the report.

The records kept by the responsible supervisor will be available for inspection. Upon completion of a landfill site, a report will be submitted that describes the quantity and general types of wastes, depth of fill, and final cover and rehabilitation steps taken.

Section 6.5

Section 6.5

NOISE MONITORING

Although there are no federal or Utah State regulations governing community noise levels, criteria and guidelines have been promulgated by several federal organizations. These are summarized in Section 4 of Ref. 46.

Since there are no existing communities close to the White River Shale Project, noise impact from the construction and operation of the project is expected to be negligible. If communities are developed outside the lease area, they will be subject to federal noise level criteria. Wild animals now using the lease lands are shy and are expected to be displaced from areas of human activity with its attendant noise. To provide a record of changes in ambient noise levels from conditions existing prior to development of the lease land, the following monitoring program is proposed.

6.5.1 MONITORING PARAMETERS

The parameters used for monitoring and assessing ambient noise include:

- Sound pressure level (SPL) — used to express the loudness of a sound, measured in dB
- A-weighted SPL — used for describing the magnitude of sounds in terms of human aural response, measured in dBA
- Cumulative distribution level (L_n) — the A-weighted SPL in dBA exceeded for a given percentage of the time, denoted by the subscript n

- Equivalent sound level (L_{eq}) — the A-weighted steady noise level that, in a stated period of time, contains the equivalent amount of noise energy as the time-varying noise during the same period
- Day-night sound level (L_{dn}) — the equivalent A-weighted sound level during a 24-hour time period with a 10-decibel weighting applied to the equivalent sound level during the nighttime hours of 10 p.m. to 7 a.m.

For further discussion of these parameters, see the Glossary.

6.5.2 MONITORING METHODOLOGY

6.5.2.1 Sampling Equipment and Techniques

The ambient noise will be recorded by digital or analog recorder with a sound measuring system that meets ANSI standards for Type 1 sound level meters (Ref. 59). The device will record A-weighted levels measured in the "Slow" meter response mode; it will sample the ambient noise at a minimum rate of once per second over the entire monitoring period; and it will be designed and packaged so that it is unaffected by outdoor exposure for a minimum of 24 hours.

The recorder will be set up at the monitoring location and calibrated prior to operation. The unattended recorder will monitor and record noise levels for a period of at least 24 hours in each location, and will be recalibrated at the end of the monitoring period. The instrumentation and measurement techniques will follow the considerations for outdoor environments presented in ANSI "Methods for the Measurement of Sound Pressure Levels" (Ref. 60). In addition, provisions will be made for measuring wind speed at the monitoring location during the monitoring period.

6.5.2.2 Sampling Locations and Frequency

To monitor the major types of activity on the lease tracts, two monitoring stations will be used. The first station will be north of the main process

area (Figure 6.2-1), and will coincide with the closest northern boundary line. The second station will be south of the processed shale disposal area at the intersection of the existing access road and the southernmost boundary line of the tract (Figure 6.2-1).

Both stations will be at the same or at a greater elevation than the main processing area and will be not less than 100 feet from the access roads. These stations will be used throughout the monitoring program. Recordings will be obtained for 2 days (two 24-hour periods) at each location during each of the following phases of the White River Shale Project.

- Before construction
- Construction of the single retort — earth-moving stage
- Operation of the single retort — full capacity
- First-train construction — earth-moving
- First-train operation — full capacity
- Second-train construction — earth-moving stage and simultaneous full capacity operation of first train
- Two-train operation — full capacity

None of the measurements listed above should be made during "extraordinary" events or situations (such as road building near the monitoring sites), since these events would render the monitoring periods atypical of the phases of construction and operation.

6.5.3 PROGRAM RATIONALE

The monitoring program is designed to provide a historical record of the present noise environment and the noise environment during construction and operation of the White River Shale Project. The data can also be applied to land-use planning in the vicinity of the lease tracts.

The dBA is widely employed to describe the magnitude of environmental noise. A-weighting, standardized in current sound level meter specifications,

correlates well with human response to noise. L_n is used by the Department of Housing and Urban Development (HUD) for qualifying areas for residential loan guarantees (Ref. 61) and L_{eq}'s and L_{dn}'s have been used by the Environmental Protection Agency (EPA) to define safe levels of noise (Ref. 62).

In a comprehensive program for monitoring noise environment, many samples must be taken of the area to arrive at a numerical representation of a noise environment, and the time-varying noise level during an entire day must be recorded and analyzed. The technique that uses each 24-hour period as a standard of comparison has been widely employed and is described in noise surveys and studies (Ref. 63).

The plant site is remote: the closest community is Bonanza, approximately 5 miles from the northern tract boundary. Owing to sound attenuation with distance and to natural barriers imposed by the terrain, monitoring the noise at the nearest community is not expected to reveal the impact of noise generated by the construction or operation of the White River Shale Project. Monitoring the noise close to the plant site will provide a better description of noise impact on the surrounding area. It will accurately reflect changes in the localized ambient noise environment due to construction and operation of the White River Shale Project. The 2-day monitoring periods are designed to describe the worst-case noise environment during these phases.

6.5.4 TREATMENT OF DATA

The data for each location will be compiled in a report for each 2-day monitoring period and will include the 24-hour L_{eq}'s, L_{dn}'s, and L_m's. In addition, histograms depicting the L_1, L_{10}, L_{50}, L_{90}, L_{99} levels and average wind speed at each location will be furnished. The data will be compared with both HUD and EPA noise criteria (Refs. 61 and 62). Applicable portions of ANSI S1. 13-1971 (Ref. 60) will be used in reporting sound level data. A report containing data showing a project-long histogram of the noise environment at each location will be prepared.

Section 6.6

Section 6.6

BIOTA MONITORING

6.6.1 PROGRAM DESIGN RATIONALE

The primary impacts of the project on the biota of Tracts U-a and U-b include:

- Destruction of vegetation and habitat by site preparation and shale disposal
- Displacement or loss of fauna from the areas occupied by the facilities and processed shale pile
- Disturbance of fauna by noise and high levels of human activity
- Potential disturbance of fauna and damage to flora by dust
- Potential growth inhibition and/or injury to plants and fauna from low-level emissions of gases such as sulfur dioxide and nitrogen oxides

Since the nondisturbed portions of the tracts proposed as the alternative wildlife habitat will also be subject to these effects, monitoring will have the dual purpose of evaluating project impacts and following the success of the Fish and Wildlife Management Plan.

The design of a statistically rigorous, yet comprehensive, monitoring program is complicated by a number of factors

- Four distinct vegetation types are present on the tracts.
- Since there is a great variety of species, only the most "important," sensitive, or representative should be monitored.

- Since most populations have a large natural variability, a sufficiently large sample of such populations is required for statistical reliability.
- Larger animals usually have low population sizes and large home ranges. Observing enough of them to produce consistently adequate sample sizes is usually difficult, if not practically impossible. Distributional trend surveys may be the most practical monitoring technique.
- Attempts to gather sufficiently large, statistically valid samples may in themselves have substantial impacts on the relatively small subject populations that are commonly found in desert ecosystems.
- Seasonal variables, such as rainfall and temperature, which can profoundly influence the biological character of a habitat, differ greatly from place to place in patterns that may not always be possible to predict or readily explain.

In recognition of these constraints, the general approach discussed in this subsection will be followed in completing the detailed monitoring plan.

At the conclusion of the two year baseline program, relevant data will be evaluated to confirm which of the biological parameters studied have been statistically reliable indicators of the baseline conditions. Parameters such as productivity, density, or population size of plant and animal species will be compared, as appropriate, within and between sampling plots for the various study intervals. In addition, parameters that appear to respond to changes in other biotic or abiotic factors will be compared using multiple linear regression analysis. Those individual factors that have acceptably low variability or show a high correlation with other factors will be of use in future monitoring programs as standards against which to measure change.

The field program will have a series of sampling stations consisting of vegetation plots and wildlife transects or trapping grids. These

will be established in each vegetation type to provide data on the selected baseline parameters. Where appropriate, the frequency of sampling will be determined by statistically analyzing the baseline data to determine the necessary sample size required for estimating within 25 percent of the true mean with a 90 percent probability. Because of the high biotic and abiotic variability described above, no off-tract "control" plots or transects are proposed. Any impact-related changes at the sampling stations will be evaluated in the following manner:

- Data from each station will be compared to the corresponding baseline data collected for that station in 1974-1976. This analysis will permit a statistical comparison of season-to-season or year-to-year changes in certain quantitative factors, as well as a nonstatistical comparison of qualitative trends.
- Data from each station will be compared to corresponding data from other stations in the same vegetation type (analysis of covariance) to provide a "between sample" control and assessment of any differential change.
- Data on the growth rates and any evidence of leaf necrosis in sensitive species from each plot will be correlated to pollutant or emission concentrations predicted by the air dispersion model. Results will be compared between plots to detect changes at different directions and distances from the emission source center.
- Browse utilization transects will be established in various locations to determine changes in grazing pressure as a result of displacement and enhancement procedures. Results will be compared with observations of seasonal density and distribution of herbivores measured during aerial survey.
- Samples of plant tissue from representative localities will be analyzed to statistically demonstrate any accumulation of toxic materials.
- Soil samples from representative localities will be analyzed and correlated with known meteorological conditions. Results will be compared between localities to statistically demonstrate any project-related reduction in microbiological activity.

The White River Shale Project will develop a data management and report form satisfactory to the AOSO. Monitoring reports will indicate the threshold values that will be treated as the point beyond which significant damage to the environment will occur. These threshold values will have to be developed in consultation with the AOSO, in recognition of the natural variability in even the most representative parameters. For this reason, no attempt will be made to establish suggested values until the analysis of data for the completed baseline program is undertaken.

The remainder of this subsection presents a discussion of the type of monitoring program that the White River Shale Project anticipates. This program was designed without benefit of the completed baseline program and represents the level of effort that the White River Shale Project presently believes to be appropriate. The parameters in this monitoring program were chosen because they represent ecologically significant factors that can serve as indicators of the general well-being of the ecosystem. Furthermore, techniques exist for quantifying the natural variation of these parameters with a reasonable level of effort. The program will be revised and finalized upon completion of the analysis of the baseline data and in response to the overall program design rationale discussed above. A most probable schedule of biota monitoring activities is summarized in Table 6.6-1.

6.6.2 VEGETATION

The plant community is probably the single most important component of the biota. Plants in the White River area are the major source of both food and shelter for the other living components of the ecosystem. Thus, healthy plant communities are essential in maintaining a healthy ecosystem.

Table 6.6-1

YEARLY SCHEDULE OF BIOTA MONITORING

Biota	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Vegetation Parameters: Plant species, plant density, plant height, plant cover, litter, productivity Sampling: 100 samples ($4m^2$ each) per each of the four vegetation types				•						•		
Birds Parameters: Species, number of individuals, age and sex, habitat Sampling: Three Emlem transects per each of the four vegetation types for a total of 24 transects per year						•						•
Rodents Parameters: Species, numbers, sex, age, body condition, nipple condition, testicular condition, habitat type, time of year, trap location Sampling: One trap grid of 144 traps per each of the four vegetation types								•				
Small Game Species Parameters: Species, numbers, sex, location Sampling: Three flushing transects for each of the four vegetation types for a total of 24 transects per year					•				•		•	
Big Game Species Parameters: Species, numbers, sex, age, location Sampling: Standardized aerial transects												•
Microorganisms Parameters: ATP concentrations, dehydrogenase activity, respiratory rate, soil moisture Sampling: Three soil samples of the top 10 cm from each vegetation type as in baseline survey, sampled before, during and after spring and fall rains				•	•	•			•	•	•	

6.6.2.1 Parameters and Methodology

The following parameters will be measured:

- Plant species
- Plant density
- Plant height
- Plant cover
- Litter
- Productivity

Methods Used. The same methods used in the baseline study will be used to measure the above parameters. Statistical reliability is an essential part of the monitoring program, but is feasible only for the dominant (and frequently occurring) plant species. These dominant species will be sampled in each of the four major vegetation types with a statistically adequate number of 2 x 2 meter quadrats. A 1 x 1 meter quadrat to determine grasses and annual herbs will be nested within the larger quadrat. These sampling procedures will involve five locations in each of the four vegetation types. Twenty samples ($4m^2$) will be taken at each of the sample locations to produce a total of 400 $4m^2$ samples (100 $4m^2$ samples per vegetation type.) Additional samples will be obtained when needed. The goal of this vegetation monitoring program is to produce estimates for each parameter that are within 90 percent of the true mean. After the baseline data are analyzed, sample sizes will be determined that will produce estimates of the mean with less than 25 percent error and with a 90 percent statistical probability. The actual number of quadrats required for each parameter can be determined only by making onsite observations, based on natural variation (which may change from year to year), and by adjusting the number of quadrats accordingly. All measurements will be made according to species at appropriate seasons (fall for perennial plants, spring for annuals). The statistical sampling program will be supplemented by general observations on plant health and vigor

and documented by a photographic record. Some visual estimates will be used in the case of plant cover. Where visual estimates are used, actual measurements will serve as reference. Species determinations will follow established botanical keys and nomenclature for the region.

Productivity. The current year's growth of aboveground parts of selected plant species will be used as a measure of productivity and will be separated according to species or groups of species such as shrub, herb, and grass. Plant species will be selected for annual productivity measurements on the basis of dominance, sensitivity to disturbance, and possible use as indicator species. A statistically adequate number of productivity samples will be taken for each of the species selected. Productivity data will consist of:

- Current year's growth of shrubs and small trees
- Current production of aboveground yield of perennial herbs
- Total production of aboveground yield of annual grasses and forbs
- Surface litter

The current year's growth of each species or group of species being monitored will be clipped, placed in a bag, dried, and weighed. To identify the location of the yield plots for future reference, metal rod markers will be driven into the ground on two corners. Since overgrazing by sheep and deer may significantly alter species composition of the plant community, the area used by these species will be monitored by either productivity assessment or another procedure as necessary.

Particular attention will be given to the growth rates of three species known to be sensitive to sulfur dioxide and nitrogen oxides. These species are Astragalus sp. (locoweed), Oryzopsis hymenoides (Indian ricegrass), and Sphaeralcea sp. (globe mallow) (Ref. 53). Field workers will make

observations for leaf necrosis and other symptoms of injury due to sulfur dioxide or nitrogen oxides. Observations will be correlated with air emissions data and dispersion modeling results to determine the strength of their linear relationship.

The analysis of plant tissues for accumulated toxic materials and the analysis of the chemical characteristics of the Utah shale are part of the second-year baseline data collection program. These data plus analysis of the characteristics of Utah shale will provide the basis for establishing a plant tissue monitoring program for initiation during the single retort phase of the project.

Location of Sampling Sites. Vegetation sampling sites will, if possible, be the same as those in the baseline survey (Ref. 7). Some sample sites will be preempted by the project and will be replaced by new sites located in similar habitats. Suggested locations for these new sites are shown in Figure 6.2-1.

When the State of Utah builds the proposed dam and reservoir on the White River, all of the riparian monitoring sites will be lost. At this time, new riparian sites will be selected and White River Shale Project's monitoring of the riparian habitat will be coordinated with the monitoring program initiated by the State of Utah.

Additional vegetation sites will be located on the processed shale pile and on revegetated disturbed areas after the new vegetation is established. This will provide documentation of the progress of the revegetation efforts and allow comparison of the vegetative cover on the processed shale pile with that of the surrounding area.

6.6.2.2 Rationale

The various types of plant community responses to stress and the monitored parameters used to detect these changes are shown in Table 6.6-2.

6.6.2.3 Treatment of Data

Data will be recorded, processed, and summarized using methods employed in the baseline survey and in the International Biological Program (IBP) Desert Biome data systems (Ref. 64). Field data will be recorded on punched tape or cards for statistical evaluation.

Table 6.6-2

PLANT RESPONSES TO STRESS AND THE MONITORED PARAMETERS USED TO DETECT THESE RESPONSES

Response to Stress	Detecting Parameters
Altered growth form	Plant height Plant cover
Altered growth rate	Productivity Litter produced
Death of adult plants, death of seedlings, reproductive failure	Changes in species composition, and/or plant failure

6.6.3 BIRDS

Because birds are highly mobile and can choose a compatible habitat, their presence in an area is an indication of a favorable habitat and the lack of substantial adverse influences. Some birds breed on the tracts in late spring and summer; others migrate through the general area in the fall or early spring; and a few species are winter residents.

6.6.3.1 Parameters and Methodology

The following parameters will be measured:

- Species
- Number of individuals
- Age and sex (where possible)
- Habitat

Methods Used. The Emlen Method line transects (Ref. 65), or a modified version, will be used to estimate population densities of the more abundant bird species. Transect counts will be made each spring and winter in areas representative of each major vegetation type. Sampling trips will be initiated 1/2 hour after sunrise and usually completed within 2 hours. An average of four 1-mile transects (only one transect can be covered per day) will be run in each of four major habitat types, and identical transect routes crossing all vegetation types will be followed. This technique allows for more uniformity of transect counts between observers. Both right-angle and radial distance will be determined for each bird detected on either side of the transect line. A detection is an actual sighting of a bird from the transect line, or it is the recognition of an unseen vocalizing bird whose location can be closely approximated. The transect strips will include observations laterally for a distance of up to 75 meters. Range finders will be used to accurately determine distances of less than 30 meters. Supplementary records will be kept of all bird species seen on the sites, to cover rare or far-ranging species whose populations cannot be adequately assessed by a transect method.

If necessary, additional observations will be made from both the ground and the air to map the locations of active raptor nests. These will be inspected at a distance to determine whether eggs or young are present. Wherever possible, a photographic record of observations will be kept.

Location of Sampling Sites. The line transects for sampling the bird populations will be the same as used in the baseline survey, except where prevented by the siting of the projects and its associated disturbances. New locations for these displaced transects are suggested in Figure 6.2-1.

6.6.3.2 Rationale

Since birds are important consumers of vegetation, insects, and other animals, the status of the bird populations will reflect the health of the many supporting ecosystem components. In addition, their mobility makes them good indicators of the level of disturbance in an area. The monitoring techniques used do not significantly affect the bird populations being studied.

6.6.3.3 Treatment of Data

Data will be recorded, statistically analyzed, and summarized using methods developed in the baseline survey.

6.6.4 RODENTS

Rodents are less mobile than larger animals. Therefore, changes in population density in this group are more likely to reflect altered survival rates than movement into or out of the study areas.

6.6.4.1 Parameters and Methodology

The following parameters will be measured:

- Species
- Numbers
- Sex
- Age
- Body condition
- Nipple condition
- Testicular condition
- Habitat type
- Time of year
- Trap location

Methods Used. Rodents will be sampled each August at the end of the reproduction season with 3 x 3 x 10 inch Sherman live traps baited with rolled oats. The traps will be placed in each of the four vegetation types in a grid pattern with 12 traps on a side and 15 meters from each other (144 traps/grid); they will be set several hours before sunset and checked several hours after sunrise. The length of time before and after sunset or sunrise varies according to the number of grids being run on any given night and the time required to set the traps. The procedure will be repeated in the same location for 5 consecutive trapping nights. Upon first capture, the animals will be marked by toe amputation so that individuals can be recognized by the unique combination of missing digits. Population densities will be calculated using the Jolly-Seber Stochastic Model (Ref. 66). These procedures will be followed for each of the four major vegetation types and will be altered, if necessary, on the basis of the topography in the area.

Location of Sampling Sites. The location of trapping grids for rodents in the monitoring program should be the same as in the baseline survey unless these areas are preempted by the project or the state's proposed dam and reservoir. Suggested new vegetation sampling sites to replace the ones displaced are shown in Figure 6.2-1. Each of the replacement trapping grids for rodents should be associated with one of the vegetation sampling sites.

6.6.4.2 Rationale

Rodents are important primary consumers of plant materials. Moreover, since rodents form a food base for most of the mammalian, avian, and reptilian predators, the natural population cycles of many of these predators are related to fluctuations in the rodent populations. The ecological significance of rodents, together with the availability of a relatively good quantitative technique, makes this a suitable group to monitor.

6.6.4.3 Treatment of Data

As in the baseline survey, the data collected will be transferred to the Desert Biome Program's Coding Form No. 139, keypunched, and verified. The data will be processed with the Small Mammal Density and Home Range Computer Program developed by Kim Marshall and available from the Desert Biome Program, Utah State University, Logan.

The analysis of the trapping data relies upon the determination of home range by the Jennrich and Turner Method (Ref. 67). Density estimates will be made using the techniques of Schnable (Ref. 68) as modified by Overton (Ref. 69). Data analysis will be performed by means of the techniques described in Balph (Ref. 33).

6.6.5 SMALL GAME SPECIES

Rabbits and other diurnal mammals consume a significant amount of vegetation and also provide a food base for raptors and other predators. This group is intermediate in its mobility, being less mobile than birds and deer and more mobile than the smaller rodents.

6.6.5.1 Parameters and Methodology

The following parameters will be measured:

- Species
- Numbers
- Sex (where possible)
- Location

Methods Used. The flushing transects technique to be used will be the same as in the baseline survey. A 1-kilometer transect has been marked out in each primary sampling site, except for the one in the riparian vegetation. A 0.5-kilometer transect has been positioned on the primary

riparian site and on each of the secondary sites. All transects have been positioned in such a way as to obtain a representative sample of the vertebrates within the vegetation types. In this technique, biologists walk the transects in the spring and winter to record the identity of animals seen and the distance from the transect line at first sighting.

Location of Sampling Sites. The location of the transects for sampling diurnal mammals will be the same as those used for birds.

6.6.5.2 Rationale

The primary small game mammal found ontract, the desert cottontail, is a cyclic species that is a hunting resource as well as a food source for the larger carnivores and the raptors. Data on other diurally active mammals, such as ground squirrels and chipmunks, will be provided by the flushing transects. The techniques used should provide statistically significant data for the more frequently observed species and will not cause any substantial impact on the species being studied.

6.6.5.3 Treatment of Data

The data will be recorded, processed, and summarized using methods established in the baseline survey.

6.6.6 BIG GAME SPECIES

Big game species, such as deer, are among the most mobile of mammals and are sensitive to disturbances by man. These two characteristics, as well as the recreational and economic importance of deer, make them an important group to monitor.

6.6.6.1 Parameters and Methodology

The following parameters will be measured:

- Species
- Numbers
- Sex
- Age (where possible)
- Location
- Percent browse utilization of selected plant species
- Number of pellet groups per acre per day

Methods Used. Standardized aerial counts by big game will be conducted over the tracts and over a 1-mile perimeter adjoining the tracts on 3 consecutive days each winter, preferably during periods of light snow cover. The transects will be flown at approximately 1/2-mile intervals and a constant altitude will be maintained along each transect consistent with safety. Two experienced observers and the pilot will count big game animals on each transect, classify them by species, and record their location. Habitat types, sex, age, and activity observed will be noted, wherever possible, as well as the weather conditions, spotting conditions, and other pertinent factors. The percent browse utilization and the pellet group counts will be determined using methods established during the second year of the baseline data collection program (Ref. 70).

Location of Sampling Sites. Both tracts and the 1-mile perimeter adjoining the tracts will be flown during each big game aerial count. The browse utilization studies and the pellet group counts will be made at the same locations that will be used during the second year of the baseline data collection program.

6.6.6.2 Rationale

The only big game species found on the tracts during the baseline program was the mule deer. Although currently available techniques will not provide statistically adequate estimates of the size of the deer population on Tracts U-a and U-b, an index of relative abundance, such as developed in the baseline survey, is achievable. And because of the ecological and economic (recreational) importance of this species, this relative index procedure is recommended for the monitoring program, even though it will not provide a statistically adequate estimate of true population.

Overgrazing by sheep and deer, the most abundant large herbivores ontract, can significantly alter the species composition of the plant communities. Area utilization by these species will be monitored with the pellet group count techniques and the level of grazing pressure will be monitored with the browse utilization techniques.

6.6.6.3 Treatment of Data

The data will be recorded, processed, and summarized using methods established in the baseline survey.

6.6.7 MICROORGANISMS

The biochemical activities of microorganisms are of primary importance in the decomposition of detritus and litter and in the replenishment of the nutrient supply needed by the plant community.

6.6.7.1 Parameters and Methodology

The following parameters will be measured:

- ATP concentrations
- Dehydrogenase activity
- Respiration rate
- Soil moisture

Three soil samples will be taken from each of the vegetation types in the same manner as in the baseline survey, except that only the top 10 centimeters will be sampled. The samples should be taken at the following approximate times:

- April (before spring rains)
- May (during spring rains)
- June (after spring rains)
- September (before fall rains)
- October (during fall rains)
- November (after fall rains)

The purpose of this sampling program is to get soil samples during the spring and fall dry-wet-dry cycles. Soil moisture is a dominant factor in determining activity levels in soil microorganisms.

6.6.7.2 Rationale

The parameters chosen for monitoring give the following information about the microbial community.

ATP Concentration. ATP (adenosine triphosphate) is a compound present in all living organisms. It has been established that the average amount of ATP in a bacterial cell is 5×10^{-11} μg. The measurement of ATP concentration is, therefore, an index for the total biomass of microbial organisms.

Dehydrogenase. This is an enzyme that makes possible the oxidation of organic compounds. Its concentration furnishes an index of cellular activity levels in breaking down organic matter in the soil.

Respiration. This parameter is measured by measuring the production of carbon dioxide and indicates the total metabolic rate for the microbial community.

Soil Moisture. This is generally the single most important environmental variable influencing microbial activity levels and can vary considerably from one location to another a few feet away. The soil moisture must be known in order to make a meaningful analysis of the other data collected.

6.6.7.3 Treatment of Data

The data will be recorded and processed using methods established in the baseline study, and comparisons will be made with results from that study.

6.6.8 TERRESTRIAL INVERTEBRATES

Although terrestrial invertebrates are recognized as important components in the desert ecosystem, they are not included in the monitoring program for the following reasons:

- Their populations have a high natural variability.
- It is very difficult to get statistically adequate data.
- Data collected would be of limited usefulness.
- These components can be monitored indirectly by monitoring segments of the ecosystem (such as vegetation and avifauna) that are intimately connected with the health of the invertebrate and microorganism communities.

6.6.9 AQUATIC MONITORING PROGRAM

Monitoring of the aquatic community during the single retort phase is not planned at this time for the following reasons:

- No direct impacts on the aquatic biota are expected since no entrainment of organisms can occur with the use of an infiltration well system. Evacuation Creek is well outside the construction and operations impact zone.
- Conditions in the aquatic community will change markedly when the State of Utah builds the dam and the reservoir on the White River.

- Data collected prior to construction of the dam and the reservoir would be of limited usefulness.
- It is assumed that the cognizant agency or agencies will establish an aquatic monitoring program after the Utah State Dam and Reservoir are completed to determine the effects of the dam and reservoir on the aquatic ecosystem.

Since White River Shale Project water needs will increase substantially with the initiation of one-train and two-train operations, and since the White River is the preferred source of the White River Shale Project's water supply, a program acceptable to the AOSS to monitor the effects of this water withdrawal will be designed. The program will be designed in concert with agency efforts, which presumably will be aimed at establishing baseline aquatic population status on a reservoir-wide basis. The object of the program will be to supplement efforts of agencies of the State of Utah to determine the effects, if any, of water withdrawal on aquatic organisms. Such effects are likely to be confined to actual withdrawal of planktonic species present in reservoir water.

PART 7

Section 7.1

Section 7.1

INTRODUCTION

Part 7 is a discussion of the alternatives considered in the work done to date on the White River Shale Project. This part is supplemented by various reports that are being submitted to the Area Oil Shale Office simultaneously with this Detailed Development Plan.

Since the Detailed Development Plan for the White River Shale Project is essentially a conceptual document, it must be understood that many of the alternative comparisons are not, at this time, based on the detailed data and analyses that would be the product of a full-fledged detailed engineering design. In many of these comparisons, there is a significant combined input of experience and judgment that must necessarily be presented in qualitative or, at best, in semiquantitative terms.

The selection criteria are set forth specifically in Section 7.2, the selection rationale in Section 7.3. These are the guideposts and procedures that have been used as a basis for all the comparisons made.

In the remaining sections of Part 7, alternatives for all facets of the White River Shale Project are discussed. These alternatives do not constitute all the possible alternatives that could be selected by the White River Shale Project. It will be obvious in many places in Part 7 that existing knowledge of shale processing is not even close to complete.

Among the alternatives is the possible exercise of the unqualified right to relinquish either lease or both leases at any time subsequent to payment of the third lease bonus installment.

Section 7.2

Section 7.2

SELECTION CRITERIA

The criteria used to select from alternatives considered for the White River Shale Project Detailed Development Plan (DDP) are derived directly from the basic objectives of the project:

- To develop mining and retorting technology for oil shale development
- To stimulate private industry to produce commercial quantities of oil from shale
- To ensure that the environmental integrity of the area is maintained to the greatest degree possible
- To develop methods and technology for the protection of the environment
- To permit an equitable return for all parties
- To develop leasing management proficiency for oil shale production

There are several criteria associated with these objectives, as follows:

- Oil shale industry development
  - The state of development of a particular technology must be sufficiently advanced to permit its practical use.
  - The particular technology must be commercially available, either by licensing agreement or in the public domain.
- Environmental protection
  - The effect that each input to and output from the White River Shale Project has on the environment, individually and cumulatively, must be in accord with the oil shale lease environmental stipulations and other pertinent regulations.

- Patterns of land use resulting from the White River Shale Project must be acceptable under lease terms.
- Patterns of manpower use and the effects of these on the general public, during both construction and operation, must be considered.
- Exchanges between any alternative considered and environmental quality, individually and cumulatively, must be taken into account.

- Economic return
  - Resource recovery, in both mining and subsequent processing, must be aimed at a practical maximum.
  - There must be sufficient energy recovery to make the project worthwhile, and the energy effectiveness of the project must be high enough to allow profitable installation and operation.
  - Operating costs for selected alternatives, as determined by accepted engineering practice, must permit profitable operation.

Section 7.3

Section 7.3

SELECTION RATIONALE

As was the case with selection criteria, a discussion of selection rationale can be tied to the basic White River Shale Project objectives that were presented in Section 7.2. The rationale governing selection of alternatives associated with each of these objectives has been developed as follows:

- Oil shale industry development
  - There has been a search for available skills to determine the state of development for the selection of appropriate technologies.
  - The availability of appropriate technologies for use by White River Shale Project was determined.
- Environmental protection
  - Effects for each alternative were identified, analyzed, and quantified.
  - The effects of each alternative were compared with existing environmental control regulations.
- Economic return
  - Information was developed on resource recovery, energy recovery, and energy effectiveness for each alternative.
  - The total system was evaluated, since a given system may have one or more elements that are not individually the best choice.
  - Operating costs were developed by standard procedure.

The final selection of the most probable case was the result of weighing the above factors in an appropriate judgmental fashion.

Section 7.4

Section 7.4

LAYOUT OF FACILITIES

This section is intended for orientation purposes. It contains a brief discussion of the principal alternatives considered in each of the named portions of this section. For further details and a consideration of selection rationale, each of the principal sections in Part 7 should be consulted.

7.4.1 MINE SHAFT LOCATIONS

Since the shale deposits underlie most of Tracts U-a and U-b and since all economically minable material is to be recovered during the operation of the White River Shale Project, the layout of underground operations has only a very limited range of alternatives. There are several technical advantages of operating from centroid locations in U-a and U-b. This, in turn, rather sharply restricts the location of mine portals at the surface. For these reasons, the number of locations considered for surface facilities has necessarily been limited. These alternatives and selection rationale are discussed in Section 7.5.

7.4.2 PROCESSED SHALE DISPOSAL

A number of disposal sites on Tracts U-a and U-b have been given serious consideration for both single retort operation of Phase II and commercial operations of Phases III and IV. Alternatives to the equipment used (1) to move the processed shale from the retort area to the final disposal area and (2) to place processed shale within the disposal area, have been examined and are described in Section 7.10. Associated problems of water management and control, as well as dust control and revegetation have been given full consideration.

7.4.3 MATERIAL HANDLING

One prominent feature of the White River Shale Project is a rate of material handling that has rarely been equaled. Material-handling methods must take overall site layout problems into account and must be responsive to the need for environmental protection. The alternatives described in Sections 7.5 and 7.6 take all these factors into consideration.

7.4.4 WATER MANAGEMENT SYSTEM

In a broad sense, the water management system for the White River Shale Project relates not only to water made available to the project but to the control and use of the water in the operation of the project. Thus, the discussion in these sections has been concerned not only with the alternatives of water supply and delivery but also with the broad intent of the project's drainage plan and water utilization.

The water supply alternatives considered involve: water from a reservoir behind a dam to be built on the White River in a location close to Tracts U-a and U-b; a supply of water from the Flaming Gorge Reservoir to be delivered through the Green River and a pipeline from that location to Tracts U-a and U-b. These and other alternatives have been discussed in Section 7.14.

The intent of the project's drainage plan, which is incorporated into the facilities described in this report, is to maximize the use of natural drainage courses while ensuring the retention of contaminants and prevention of erosion as a result of project activities. Drainage and contaminant control as well as erosion control will be accomplished with ditches, surface grading, revegetation, stabilizing techniques, and dam impoundments. These facilities and alternatives are discussed in Section 7.14.

Since reuse of water is an essential ingredient in the plan presented in this report, wastewater treatment methods and facilities have been discussed in detail, and an evaluation of alternatives is presented in Section 7.15.

7.4.5 PROCESS AND OTHER FACILITIES

The specific layout of process and other support and ancillary facilities has been limited by the underground operations and by the nature of Tracts U-a and U-b, which contain largely rough and rugged terrain. In a discussion of the alternatives presented in Sections 7.7, 7.8, 7.12, and 7.13, the limited extent of available options has been taken into account and a selection rationale has been presented. Perhaps the most important factor in facilities location has been that of transportation related to the very large volume and weight of materials that will be handled. The impact of these operations on the environment has been recognized and evaluated.

7.4.6 SITE PREPARATION

The rough and rugged terrain of Tracts U-a and U-b, together with the need to mine most of the shale ore from beneath these tracts, leaves little latitude in selecting the most appropriate site in terms of earth moving during the construction phase. Within the limits of available alternative locations, every effort has been made to minimize earth disturbance. Site preparation methods and procedures have been adapted to the particular area. A description of this subject is found in Section 7.9.

7.4.7 ACCESS

Access to Tracts U-a and U-b for movement of men, material, and supplies, both to the project and away from it, has been discussed with a wide variety of state and government authorities who are interested

in immediate and long-range plans of access corridors. These conversations have, of necessity, been preliminary in nature, but they have nevertheless been very useful in formulating the provisions for the most probable plan of action under this plan presented by White River Shale Project. It is the intent that further consideration will be given to all of these very important corridor access problems as the project develops and additional definitive data become available.

Section 7.5

Section 7.5

MINING

This section discusses common mining methods and evaluates their potential for extracting oil shale from Tracts U-a and U-b. Besides the environmental and economic criteria against which all activities of the White River Shale Project must be measured, the mining operation is further constrained by the lease stipulation that all operations must be confined within the boundaries of the leased tracts. The physical features associated with and affected by mining include all mining and crushing facilities, shale stockpiles, removed soil, and the processed shale disposal area. Various haulage systems are also evaluated. Three categories of mining were investigated: surface, underground and in situ.

7.5.1 SURFACE MINING

The surface terrain of the area consists primarily of deep canyons and pinnacle-topped ridges, and the oil shale of acceptable quality for retort feed material lies 600 to 1,200 feet below the surface under waste rock and low-grade oil shale. The depth of the commercial mining zone makes any kind of surface mining environmentally unacceptable and technically and economically impractical. The Bird's Nest Aquifer would have to be dewatered before removing it by stripping. The surface would, of course, also be completely removed. The impossibility of disposing of the overburden and processed shale on site while achieving any reasonable amount of resource recovery makes surface mining an unlikely method at this time.

7.5.1.1 Strip Mining

A typical strip mining operation is illustrated in Figure 7.5-1. In addition to the reasons enumerated above, the hazard presented by slope instability of the spoil bank at this extreme depth eliminates strip mining as a possibility for the White River Shale Project.

7.5.1.2 Open Pit Mining

Theoretically, open pit mining of the present commercial zone could optimally recover 80 percent of the available ore (as compared with the anticipated 70 percent in the most probable plan); however, this figure could never be actually achieved because of the area required for disposal of overburden and processed shale. The stripping ratio would be close to 10 tons of overburden per ton of shale mined. Although in the late stages of the project some of the previously removed overburden and processed shale could be placed back in the pit along with that currently being produced, rehandling large volumes of waste material is uneconomical. A typical open pit mine is shown in Figure 7.5-2.

7.5.2 UNDERGROUND MINING

Conducting the mining underground causes little surface disturbance, is economically practical, and is the traditional approach to mining ores at depths at which oil shale is found in Tracts U-a and U-b. Subsidence is an important environmental effect to be considered. The Bird's Nest Aquifer overlies most of the mining area, and the probable effect of the mining on this aquifer is discussed in Subsection 4.5.3. The facilities that will be built aboveground are described in Section 3.5.

Since the mining zone does not outcrop within the lease boundaries, all underground mining methods must include facilities to either hoist or convey the mined shale to a surface retort site. The most probable plan

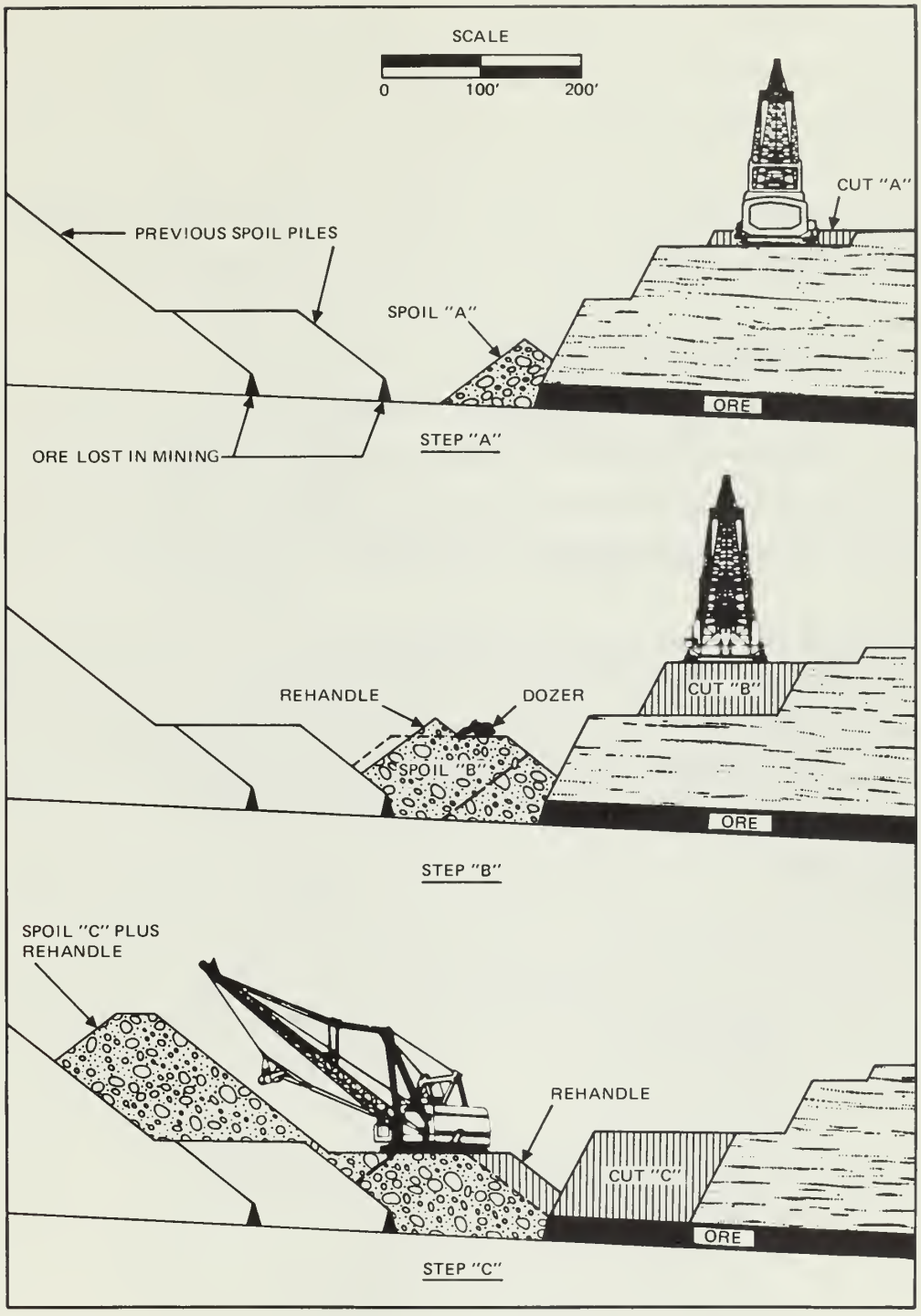


Figure 7.5-1. A Typical Strip Mining System

proposes inclines to the surface, but an alternative solution would be a series of vertical shafts and an entry system within the mining zone to the existing working areas.

Common underground mining methods include room and pillar, longwall, and block caving. These methods are discussed below.

7.5.2.1 Room and Pillar Method

Room and pillar mining is appropriate in relatively flat-lying tabular ore bodies, such as in U-a and U-b. Physical testing of drill cores shows the strength of the oil shale to be such that subsidence will be minimal if the pillars left are approximately 60 by 80 feet in girth (Ref. 71).

Conventional drilling, blasting, loading, hauling or conveying, and crushing will be employed in this method of mining. Continuous mining machines are not practical at this time because of the excessive fine material they create and the hardness of the rock. All room and pillar mining methods considered for U-a and U-b have the following common advantages and disadvantages:

- Advantages
  - Resource recovery approaches 70 percent.
  - Minimal subsidence occurs when pillars are left intact.
  - High productivity is possible.
  - The method has been used in mining oil shale.
  - Since all development is in the ore zone, all excavated material is used.
  - The method is historically safe.
  - Selective mining for grade is possible.
- Disadvantages
  - A complex ventilation system is required.
  - A large number of working places complicate logistics.

Room and Pillar – Single Pass. In this method, the entire ore thickness is taken in one pass; a representative plan is shown in Figure 7.5-3. Single-pass room and pillar mining, as applied to Tracts U-a and U-b, has the following advantages and disadvantages when compared with room and pillar bench mining:

- Advantages
  - Blending for grade control is good.
  - Fewer blasting cycles create less pillar disturbance.
  - Drilling equipment can be standardized.
  - Fewer equipment moves are required for a given production.
- Disadvantages
  - Height of mining horizon requires very large equipment.
  - Extremely large equipment is not presently available.
  - Room sizes constrain efficient maneuvering by large equipment.
  - Visibility is poor at great heights for drilling and scaling.

Room and Pillar – Benching. For thick deposits, a benching system of room and pillar mining is used to mine the ore from two or more levels or benches. Figure 3.5-8 shows a typical two-bench configuration. Bench mining has the following advantages and disadvantages when compared to with single-pass mining:

- Advantages
  - Applicability has been proved in prototype oil shale operations.
  - Equipment technology has been developed.
  - Equipment can maneuver acceptably.
  - Visibility is better for drilling and scaling.
- Disadvantages
  - Pillars are exposed to more blasting cycles.
  - Equipment must move more for given production.

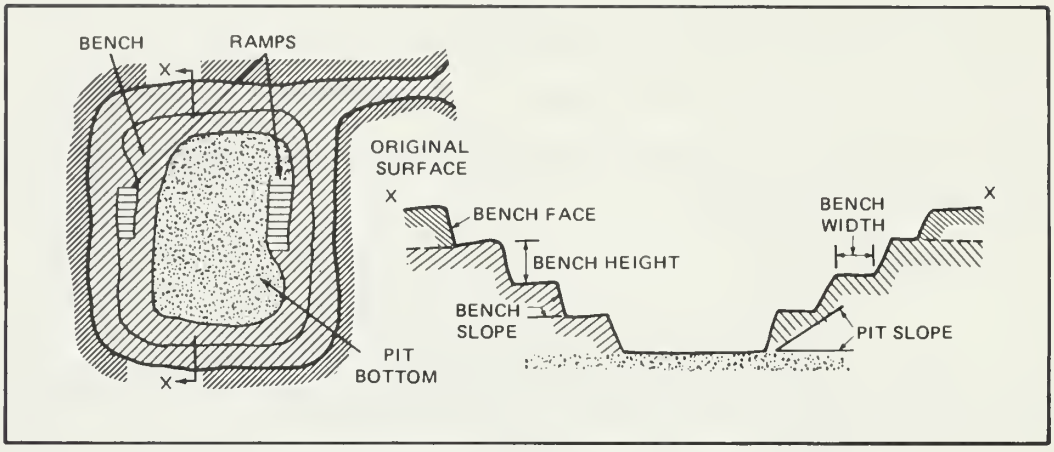


Figure 7.5-2. A Typical Open Pit Mine

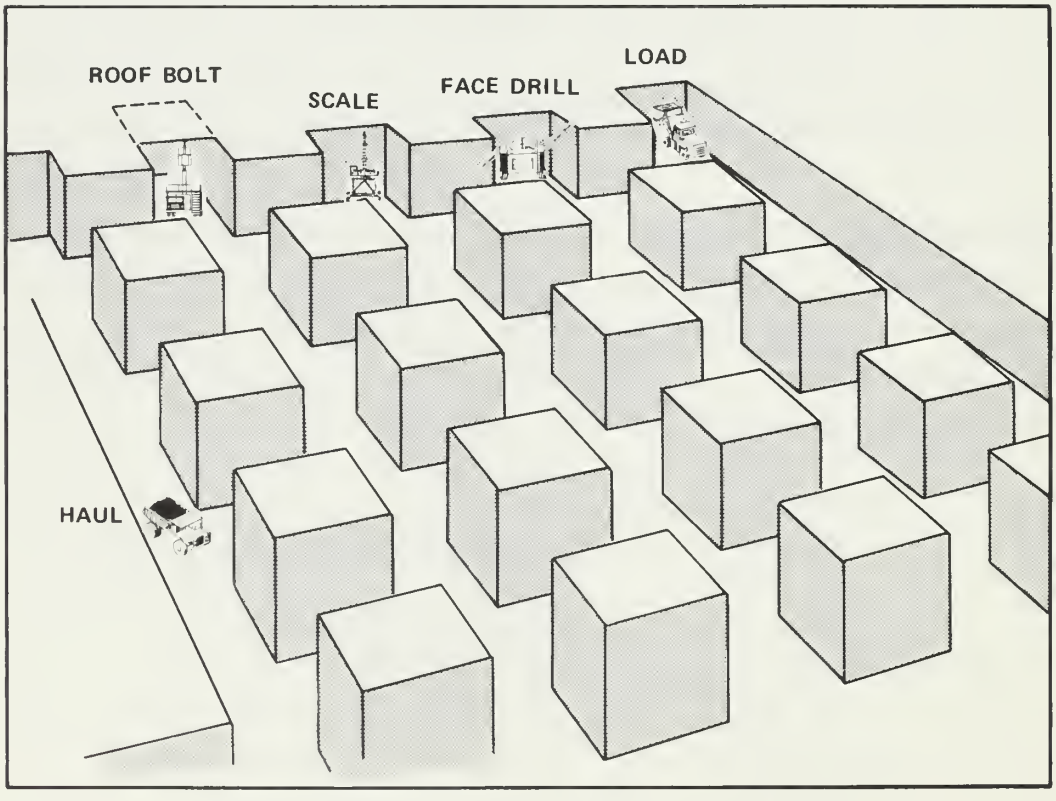


Figure 7.5-3. Single-Pass Room and Pillar Mining

7.5.2.2 Longwall

Longwall mining in thin seams results in a high resource recovery and permits a simplified ventilation system. A theoretical system for mining a thick seam is shown in Figure 7.5-4. Thick seams or veins have not been mined successfully by this method because of the difficulty in controlling the roof before it caves, and caving and subsequent subsidence are inherent in longwall mining. Since subsidence is to be minimized and the zone to be mined is relatively thick, longwall mining is not the preferred mining method.

7.5.2.3 Block Caving

The vertical extent of oil shale that is presently suitable for surface retorting does not exceed 75 feet in the lease area. Block caving is most applicable in much thicker or massive deposits; in this deposit, development costs would be prohibitive. The method is illustrated in Figure 7.5-5. Oil shale tends to break into large slabs and blocks that would complicate recovering ore from the draw-points. The relatively thin zone to be mined and the need to minimize subsidence preclude block caving from the present program.

7.5.2.4 Other Underground Methods

While there are many other underground mining methods, none of them appears advantageous for the Utah lease tracts. Sublevel stoping is a possibility, but the relatively thin mining zone precludes it from present plans.

7.5.3 IN-SITU PROCESSING

The present state of the art of in-situ mining is unproven and not sufficiently demonstrated to warrant its use at Tracts U-a and U-b. There is, however, a possibility that in-situ technology may be used in the future to recover oil from the leaner overlying shale and/or the remaining pillars that is now not considered commercially recoverable.

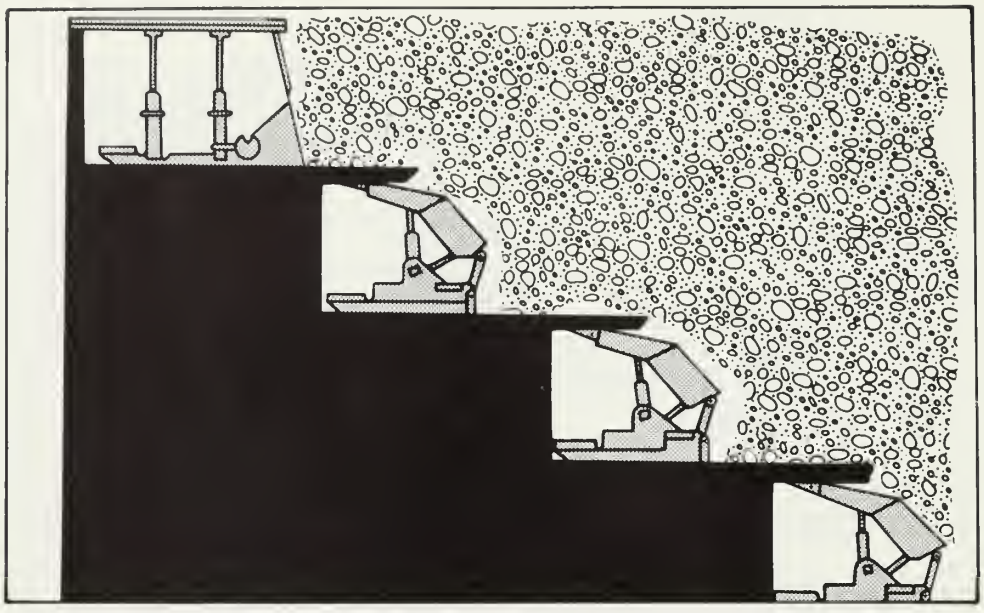


Figure 7.5-4. A Typical Longwall Slicing System

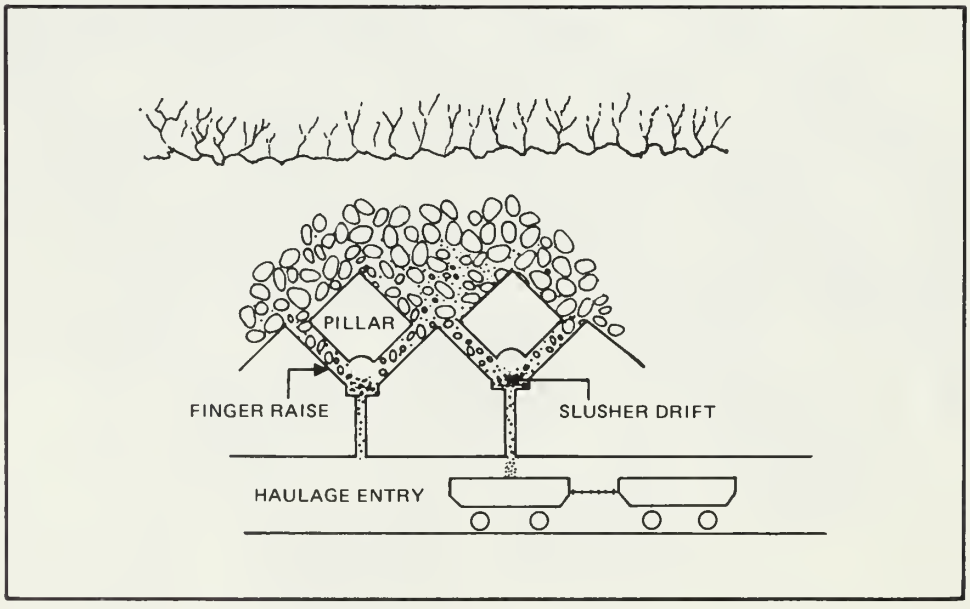


Figure 7.5-5. A Typical Block-Caving System

In the in-situ process, oil is released by retorting the oil shale in place. A significant amount of the shale is removed during development of the retort chambers. The underground retort chambers are then formed by blasting to produce a mass of shale rubble which fills development openings and the area that was blasted. This configuration is shown in Figure 7.5-6. The shale that is extracted may be retorted at the surface (with some concomitant problems of processed shale disposal), but the balance of the shale is burned underground by a process in which air and, possibly, an external fuel source are introduced. Liquid oil is then collected and pumped to the surface for upgrading.

Little is presently known about the potential side effects of this type of processing. Underground processing may, through temperature and pressure changes, alter aquifer hydraulics. Dewatering operations may produce large quantities of salty groundwater for disposal, and, if groundwaters reenter abandoned in-situ retorts, they may be contaminated with organic compounds.

Since experience to date with "pure" (no underground mining) in-situ experiments has not been promising, this method is rejected at this time.

7.5.4 HAULAGE SYSTEMS

Several possible haulage systems have been investigated for use in the project and are discussed in the following paragraphs. They consist of some configuration of trucks, conveyors, or rails. As a rule, a conveyor system generates the least dust and trucks the most dust, but trucks are the most versatile form of haulage. At present, truck or conveyor haulage are being considered. Whichever system is used, dust will be a problem and will have to be controlled in accordance with state and federal regulations. Several workable dust control systems do exist, and the most appropriate ones will be used for the final haulage system selected. Exhaust and emission control will also conform to all applicable regulations.

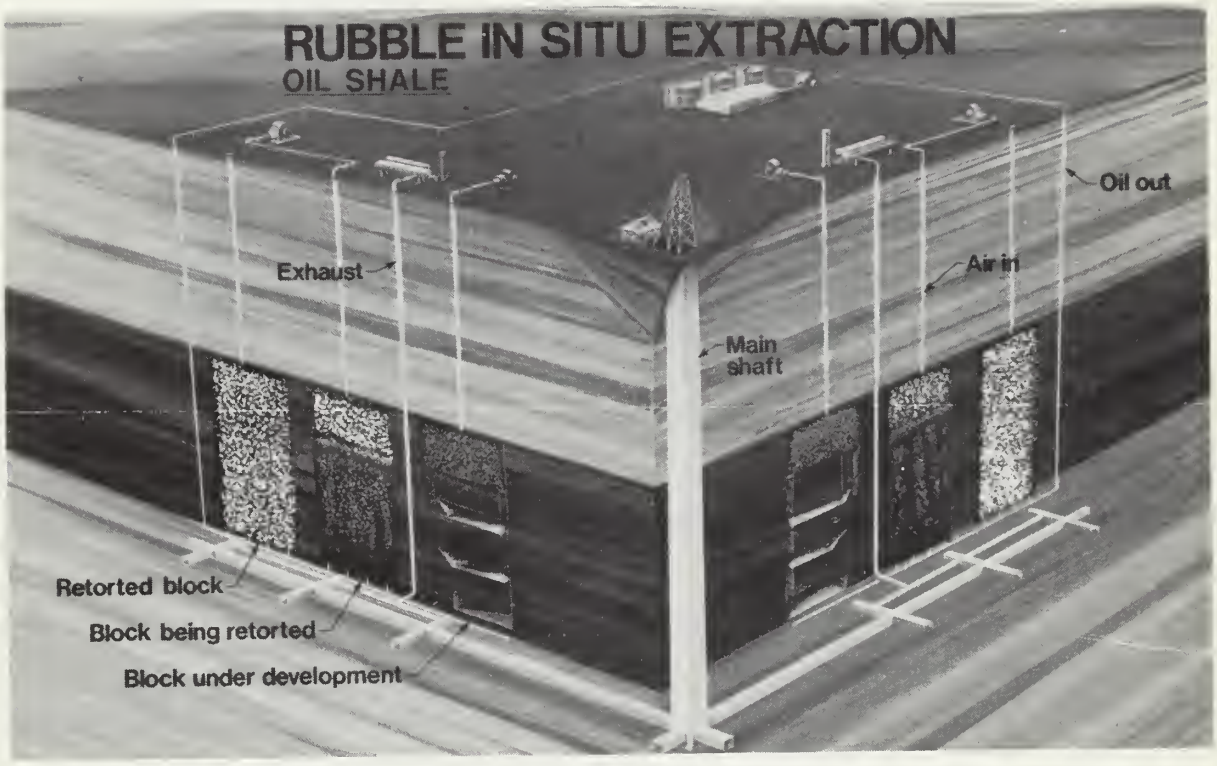


Figure 7.5-6. In-Situ Processing

The haulage alternatives discussed all assume that primary crushing takes place underground.

- If the haul distances are not excessive, truck haulage from the face to a centrally located primary crusher is an acceptable method. However, increased haul distances require additional trucks and drivers, which, in turn, increase ventilation and dust control requirements.
- If haul distances are greater than 2 miles and track grades are less than 3 percent, truck haulage from the face to a main line rail haulage system with centralized primary crushing is another applicable method. A rail haul system method is appropriate for higher production requirements, but may not be feasible if the rate of development is slow.
- Truck haulage from the face to a primary crusher followed by a conveyor belt in a main entry reduces the requirements for trucks, men, and ventilation air. Portable crushers, capable of the throughput rates required in a commercial operation, are under investigation. This method is advantageous if crusher and dust collection technologies are sufficiently developed.
- A load-haul-dump system from the face to a portable crusher and cross belt, located in the panel, coupled with a main belt to a central hoisting location, eliminates trucks from the haulage scheme. However, as the mine advances, the number of loading machines must increase to handle the haulage function. Portability of crushers and necessary dust control equipment are more critical when operating within the mining panels. The method has merit if the necessary equipment and technology can be developed.

One of the many reasons for the on-tract staged development of Phase I and Phase II is to test and refine underground haulage systems and mining equipment for the Phase III and Phase IV commercial facilities.

Section 7.6

Section 7.6

FEED PREPARATION ALTERNATIVES

This section presents the various processes and machinery considered in choosing a method of preparing oil shale for retorting. Advantages and disadvantages are weighed, where possible, for each decision.

7.6.1 PRIMARY CRUSHING

Primary crushing will take place underground and will reduce the mined shale to sizes that can be transported easily by either truck or conveyor — probably 10 inches. Locating this treatment step underground has an environmental advantage in that it does not create surface disturbance.

7.6.1.1 Roll Crusher

Currently, a roll type crusher (see Figure 7.6-1) is recommended for primary crushing. It is superior to the other types of crushers that could be used on shale in the following ways:

- It slips less on shale-type material than do jaw or gyratory crushers.
- It produces the least amount of fines in breaking shale.
- It has the most likely possibility of being made portable.
- It has been used successfully on oil shale and performs well on wet and sticky materials.
- It is the smallest and requires little headroom.
- It can be easily disassembled for underground installation.
- It produces the greatest percentage of large material in the desired size range of minus 3 inch to plus 1/2 inch.

- Its steady, continuous movement requires somewhat less massive construction than does an inertia-overcoming method
- It can handle pieces of shale as large as 54 by 30 inches

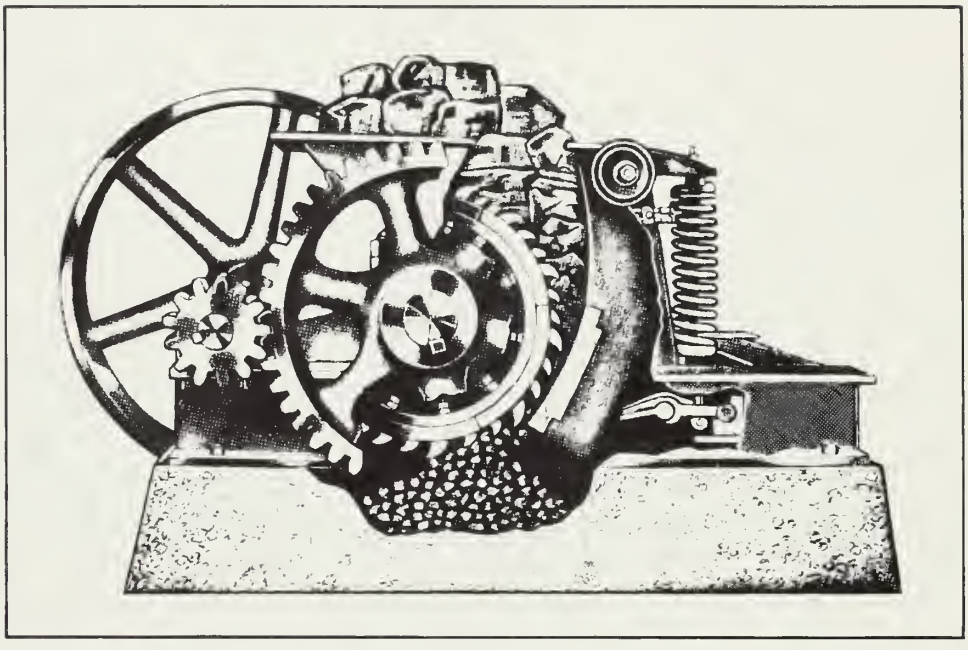


Figure 7.6-1. Typical Roll Crusher

7.6.1.2 Jaw Crusher

Jaw crushers are also relatively small and easily disassembled for installation and maintenance, and produce a favorable ratio of larger pieces of shale to fines. Their chief disadvantage is that they tend to deform or mash the oil shale (which is somewhat spongy) instead of breaking it, which leads to clogging and less efficient operation. They also require a lot of power and a regulated feed.

7.6.1.3 Impactor

An impactor is a type of hammermill in which the shale material is reduced by rotating hammers. This method has one distinct advantage:

since the impactor can be used as a mobile unit, it can be operated close to any working area. This diminishes truck haulage and increases belt haulage, a virtually continuous operation powered by electricity and whose dust-creating points can be shielded. However, this advantage is outweighed by the large amount of fines created.

7.6.1.4 Gyratory Crusher

A gyratory crusher operates on the principle of one eccentric cone revolving inside another to crush the material between them. Its advantages are high tonnage throughput and the ability to handle slabby material. These seem to be outweighed by the following disadvantages:

- It is very large and difficult to install underground and would require very large excavations.
- Because shale is compressible to some degree, a gyratory crusher would tend to mash the oil shale and thus would be less efficient than other types of crushers.
- It tends to produce a larger percentage of unwanted fines.

7.6.2 COARSE RAW SHALE STORAGE AND RECLAIMING

Raw shale will be stockpiled after primary crushing (eventually as much as 1 million tons) to ensure continuing feed to secondary crushing if mining and primary crushing are interrupted. A tripper conveyor is planned to distribute the oil shale, but a rail-mounted traveling stacker is a possible alternative method of stockpiling. Transport conveyors from the mine would discharge the primary crushed oil shale onto the stacker belt, and a traveling stacker would distribute shale to the stockpile.

The stockpile will be located on the surface near the secondary crushers as shown in Figure 3.4-4. The dust control program is described in Section 4.1.

7.6.3 SECONDARY CRUSHING

Roll crushers are preferred for the surface secondary crushing because they do not produce a large quantity of fines and, consequently, not a large amount of dust. They are also effective for size reduction of slabby material. Two alternatives were considered: impactors and cone crushers.

7.6.3.1 Impactors

Impactors (briefly described in Subsection 7.6.1.3) do not clog as easily as compression-type crushers. However, they may not be suitable for oil shale because they 1) generate an excessive amount of fines and 2) they produce wear on hammers and abrasion-resistant parts that is so high as to make maintenance cost prohibitive.

7.6.3.2 Cone Crushers

Cone-type crushers operate on a principle similar to the one involved in gyratory crushers. The cone-type crusher would tend to clog on shale material, would produce too high a ratio of fines, and would not work best in the size range involved.

7.6.4 MATERIAL HANDLING

The preferred transportation scheme for Phase II is to truck mined oil shale to the primary crusher, then send crushed shale by belt from the primary crusher to the stockpile. Trucks provide haulage flexibility in the initial mining phases. Once the large material is crushed, it can be transported by electrically powered, continuous belts where dust and ventilation control is easier.

7.6.4.1 Fines Disposal

Current plans call for disposing of the fines with processed shale during Phase II if other methods of handling the fines are uneconomical. An alternative would be to stockpile this material to await later processing

when suitable retorts are installed (approximately 4 years). In the former method, some of the resource is discarded; in the alternative, there is additional cost associated with storing the material for a long period of time and of handling it twice. Possible tradeoffs between these two courses of action must be evaluated. At present, it is not clear 1) what the acceptable size range is for IH and DH retorts and 2) what the typical size consist might be for U-a and U-b shale processed through roll crushers. Therefore, in Phase III design it will be determined how many, if any, fines retorts will be required.

The subject of material handling is discussed further in Section 7.10.

7.6.4.2 Skip Hoist or Bucket Elevator

Instead of conveyor belts from the underground primary crushers to the surface stockpile as proposed in Phases III and IV, skip hoists or bucket elevators could be used to transport the shale. The only advantage gained would be the cost reduction in sinking a vertical shaft rather than constructing long inclines. The two methods themselves have no operating advantage over belts. A typical skip hoist installation is shown in Figure 7.6-2. In actuality, bucket elevators that will operate for the lift required in Tracts U-a and U-b have not yet been designed. A conveyor belt haulage system from the mine to the surface has a total cost and availability advantage over shaft hoisting at these large tonnage rates.

7.6.5 DUST CONTROL

The preferred dust control system will use scrubber-type dust collectors in conjunction with water spraying at critical, exposed points. Bag houses, the only alternative considered, were rejected because they require much more maintenance than scrubbers and would be likely, in this particular shale operation, to become clogged by moist dust.

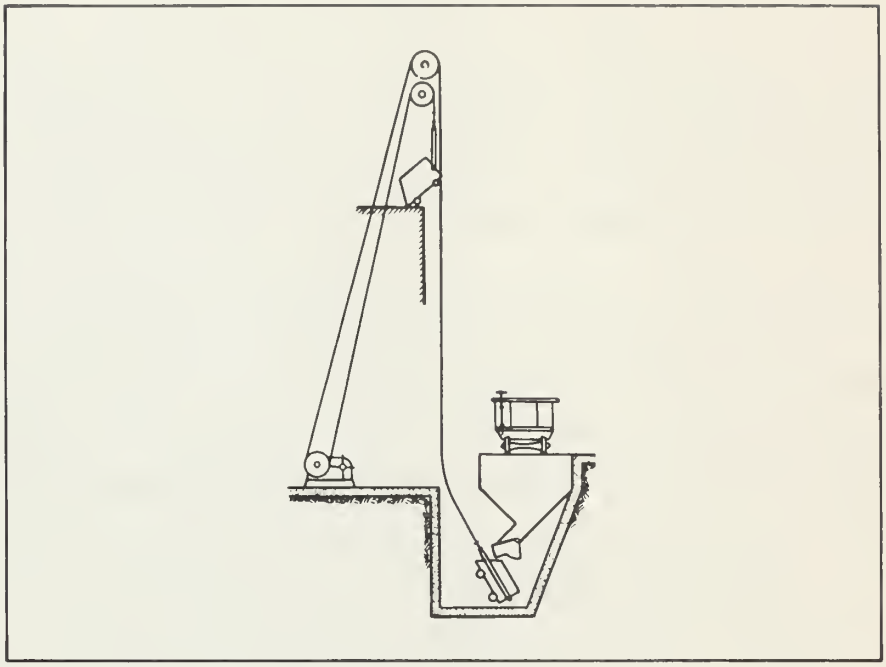


Figure 7.6-2. Double-Bucket Hoist for Large-Scale Deep-Lift Operation

Section 7.7

Section 7.7

RETORTING

In this section the fundamental ideas of retorting are explained and basic terms are defined, the major alternative retorting processes are described, and environmental impacts of the alternative processes are compared. It is concluded that, for the White River Shale Project, the most satisfactory retorting system is a combination of vertical, direct heated and indirect heated retorts for processing the bulk of the shale, with fines handled in indirect heated "fines" retorts.

7.7.1 INTRODUCTION

The term "retorting," as applied to oil shale, signifies the process of adding heat to the shale to decompose its organic material into gas and liquid hydrocarbons. There are two basic categories of retorting: in-situ and aboveground. In the in-situ process, thermal decomposition takes place below ground. Since this process is still in the developmental stage, it was not considered for application at this time (see Section 7.5). In the aboveground process, retorting is performed in large vessels (retorts) in which the heat is applied to crushed shale. Two types of retorting processes exist: in one, the retort is direct heated (DH); in the other, the retort is indirect heated (IH).

7.7.1.1 Direct Heated Retort

A direct heated (DH) retort is one in which oil is recovered from the shale by means of heat that is generated entirely within the retort. A

simplified schematic diagram of a DH retorting system is shown in Figure 7.7-1. Carbon on the shale and some gas are burned within the retort. This combustion heats the shale, causing oil and gas to be released, and the products flow out of the retort.

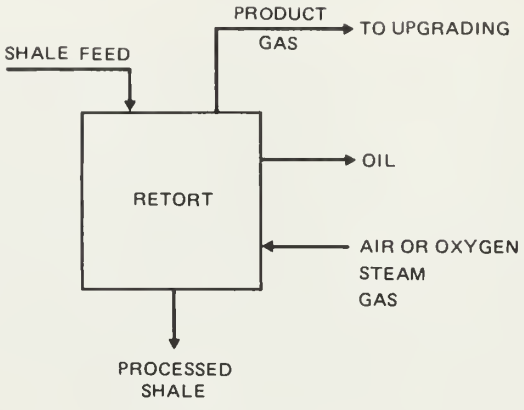


Figure 7.7-1. Direct Heated (DH) Retorting System

7.7.1.2 Indirect Heated Retort

An indirect heated (IH) retort is one in which gas and oil are recovered from the shale by means of heat that is generated outside the retort. A simplified schematic diagram of an IH retorting system is shown in Figure 7.7-2. A heat carrier (either a gas or a solid) circulates continuously through the retort to heat the shale, the heat being supplied to the carrier by the burning of fuel in a heater. As the shale is heated, oil and product gas are released and exit the retort.

The fuel that is used in the heater of an IH process may be any conventional fuel. When this fuel is mixed with air in the heater and combusted, the result is a waste product called flue gas. In all the processes to be discussed in this section, the flue gas either is clean or can be made so by further treatment.*

* As used in this discussion, "clean" is defined as meeting appropriate regulations. This is discussed fully in Parts 4 and 5.

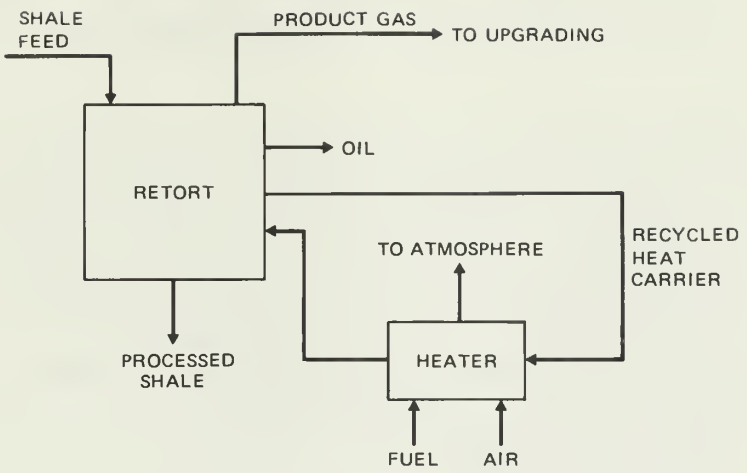


Figure 7.7-2. Indirect Heated (IH) Retorting System

7.7.1.3 Product Gas and Oil

The product gas generated from the DH and IH retorting of the oil shale consists of combustible hydrocarbons, oxides of carbon, sulfur compounds (particularly hydrogen sulfide), and, in the case of a DH retort, nitrogen gas if air is used for combustion, which is the usual case. In both the DH and IH processes, the product gas leaving the retort is processed for removal of sulfur. The treated material is a fuel gas that produces a clean flue gas when burned.

Either DH or IH product gas can be used as a fuel within the facility. Because DH gas ordinarily contains a significant amount of nitrogen, the product gas from a DH process is a low-Btu (low heating value) gas. On the other hand, the product gas from an IH process is a high-Btu (high heating value) gas. A high-Btu gas has several advantages over a low-Btu gas: it is a superior fuel; it is more easily transported (less volume per Btu); and it is more adaptable to further processing, e.g., it is suitable as a hydrogen plant feedstock or as a marketable heating gas.

The oil from the retorts is a crude shale oil containing significant amounts of contaminants and, depending upon its final use, it must be upgraded to minimize undesirable environmental effects.

The upgrading process presently planned involves use of both the retort product gas and the crude shale oil in a complex combination of operations, as discussed more fully in Section 7.8, "Shale Oil Upgrading." The differences in environmental impact of the various retorting processes, relative to product gas and oil, become more apparent when the system of retorting plus upgrading on tract is considered as a whole.

7.7.1.4 Raw Shale Feed

Before the raw shale can be processed in an aboveground retort, it must be crushed. The size of the crushed raw shale that can be processed varies from one type of retort to another. Some retorts require extremely fine particles (from approximately 1/2-inch maximum dimension down to a powder), while others can handle only coarse shale greater than approximately 1/2 inch. Since the mining and crushing that precede the retorting always produce some shale finer than 1/2 inch, it is clear, from the standpoint of resource recovery, that the retorting systems with no lower size limitations on the raw shale feed to be processed must be studied carefully.

It is estimated that approximately 10 to 15 percent of crushed raw shale feed will be smaller than 1/2 inch. This does not mean that 10 to 15 percent of the oil content of the mined shale will be lost by retorting systems that cannot process this fine shale, for such fine shale contains somewhat less oil per unit weight than the coarse shale, and retorting systems operate at different recovery efficiencies.

7.7.2 RETORTING PROCESSES

The major retorting processes considered in this plan are: Lurgi, McDowell-Wellman, Paraho, Petrosix, TOSCO II, Union Oil, and Bureau of Mines.

Since the Bureau of Mines process is essentially an early version of the Paraho process, it will not be considered here. Simplified diagrams and brief descriptions of the other six schemes are given in Figure 7.7-3.

Table 7.7-1 summarizes the major features of the retorting systems that are being considered in this part of the report. Several items in the table are worth commenting upon:

- The Lurgi and TOSCO II schemes are capable of processing all the shale that is mined. In the Paraho, Petrosix, and Union schemes, the preferred raw shale feed particles are 1/2 inch and larger. It should be noted, however, that there is not necessarily any correlation between the ability to process fine shale particles and the final yields of oil and gas from the raw shale feeds. Other factors, related to the design features of the retorting systems, play an important role in determining these yields.
- The Lurgi IH retort and all the DH retorts except the McDowell-Wellman use carbon on the shale as a heat source to extract oil from the shale. In the TOSCO II, Petrosix, Paraho IH, and Union Oil IH retorts, retorting heat must be obtained from conventional fuels. Thus, the DH retorts and the Lurgi IH retort produce more of the total available energy from raw shale than the aforementioned IH retorts.
- Disposal of processed shale is the major environmental problem in the retorting of oil from shale. The processed shale can have different characteristics, with different degrees of environmental problems resulting. Processing of fines generally presents greater problems.
- For the various retorting alternatives, the product gas and oil produce different environmental impacts. These impacts are discussed in Section 7.8.

A combination of vertical DII and IH retorts for processing the bulk of the shale and fines-type retorts for fines (minus 1/2 inch) has been selected for the White River Shale Project. This combination is equivalent to any other process (or processes) in terms of resource recovery and yields a better economic return than any other process (or processes) when considered in combination with on-tract product upgrading as a total system.

Since the art of retorting and retort design is evolving very rapidly, the WRSP choice of a vertical retort may finally be one of the foregoing, as described, or an improvement thereon, including Paraho and Union, even though Union is not available by license at this time. Similarly, the choice of the precise mode for processing of much smaller quantity of fines will be between TOSCO and Lurgi or other modifications.

7.7.3 PROCESSED SHALE COOLING

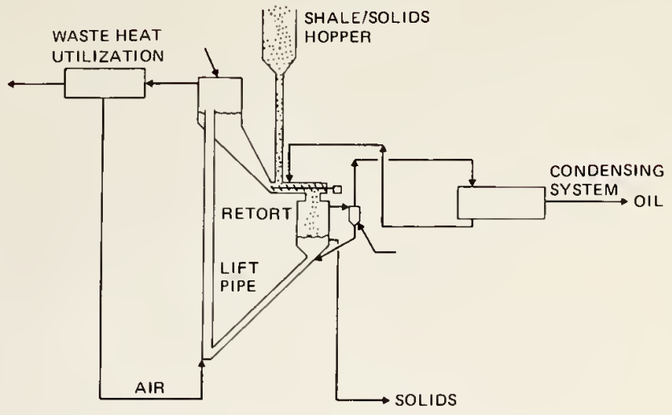
There are three basic approaches to the operation of cooling processed shale from the retort outlet conditions to the temperature level that will permit safe and reliable transport and disposal:

- Spraying with water on conveyors
- Air cooling on moving grates
- Rotary drum water cooling

7.7.3.1 Spraying on Conveyors

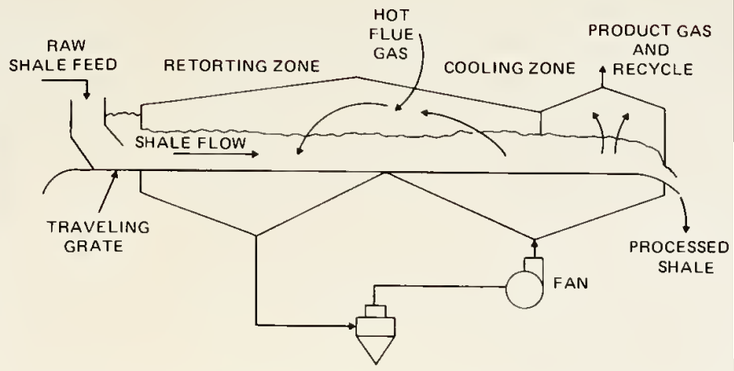
In this system, water would be sprayed onto material as it travels on belts and as it is transferred from one belt to another to obtain adequate cooling and mixing. The entire system would be enclosed, and dust-laden steam would be treated by a high-efficiency wet scrubber system, with heat rejection to the atmosphere, as described in Subsection 3.7.3.2.

LURGI PROCESS



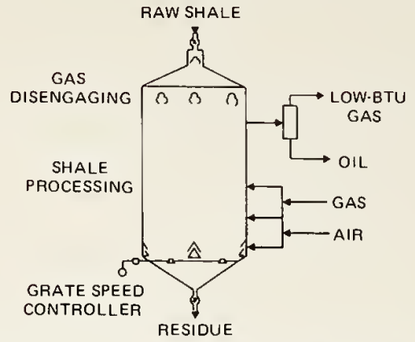
This method processes minus ½-inch shale in the IH mode. Carbon in the processed shale is burned in the lift pipe, and the hot circulating processed shale from the lift pipe mixes with raw shale in a screw conveyor to bring about an intimate mixing of the solids.

McDOWELL-WELLMAN PROCESS



This process is operated as a DH retort and can accept both fine- and coarse-grade shale. This retort is a doughnut-shaped structure; shale is carried on a traveling grate in a circular path, and is successively heated and cooled by a gas passing through the grate. In the retorting zone, a gas/air mixture is combusted for heating the shale.

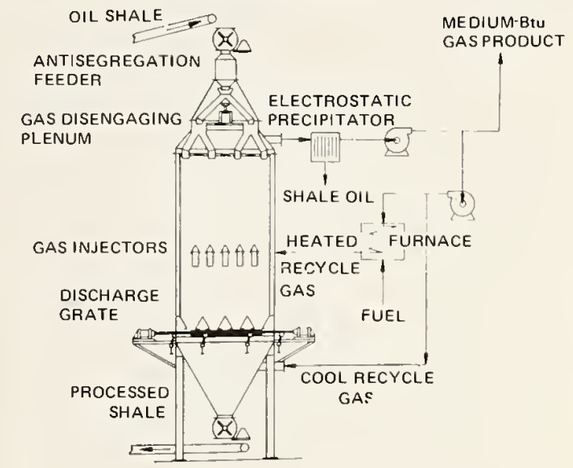
PARAHO PROCESS



There are two types of Paraho processes: DH and IH. Both methods process minus 3-inch plus ½-inch shale in a vertical shaft retort in which the solids flow downward. In the DH retort, the gas/air mixture is injected at three bed levels and flows upward. The product oil leaves the top of the retort as an oil mist carried by the product gas. In the IH retort, heat is supplied by a fired heater which heats a gas stream before injection into the retort.

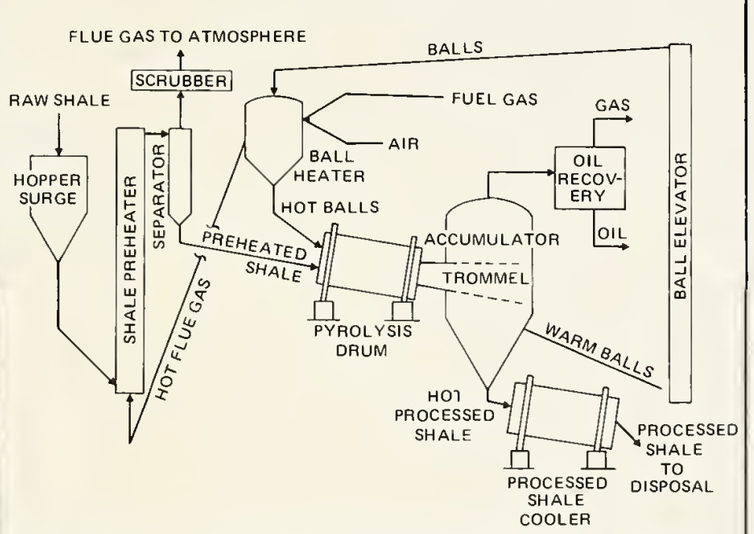
The indirect heated retort will have no air injection, and the recycle gas will be heated in a separate furnace external to the retort. The heated gas will be injected into the shale bed at multiple levels. The retort will be almost identical to the direct heated retort.

PETROSIX PROCESS



The Petrosix method processes minus 3-inch plus ½-inch shale in a vertical-shaft retort. Within the retort, rock flows downward and the heating gas flows upward. Heat for the retorting is applied by a gas heated in a furnace outside the retort, and the hot gas is injected into the retort at one bed level.

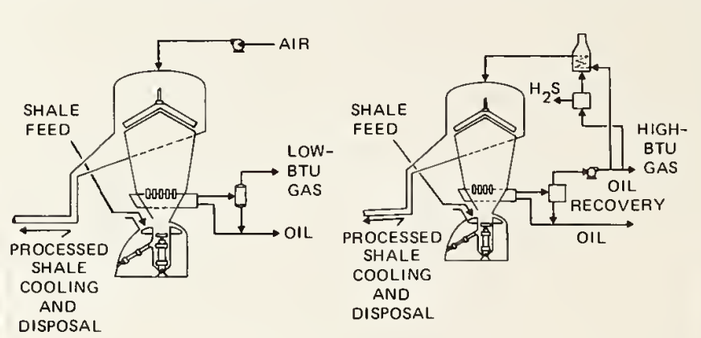
TOSCO II PROCESS



The TOSCO II method processes minus ½-inch shale in an IH retort. The shale is heated to retorting temperature in the pyrolysis drum by hot ceramic balls. The mixture of shale and ceramic balls is then separated in a trommel.

UNION OIL TYPE "A" PROCESS

UNION OIL TYPE "B" PROCESS



The Union Oil method processes minus 3-inch plus ½-inch shale in a vertical shaft retort. Within the retort, rock flows upward (through the action of a rock pump) and the heating gas flows downward. The retort can be either DH or IH. The Type A retort is DH; the Type B retort is IH.

Figure 7.7-3. Simplified Diagrams and Brief Descriptions of Retorting Processes

Table 7.7-1

COMPARISON OF THE
MAJOR RETORTING PROCESSES

	Lurgi	McDowell-Wellman	Paraho		Petrosix	TOSCO II	Union Oil	
							Type "A"	Type "B"
Type of heating	IH	DH	DH	IH	IH	IH	DH	IH
Resource recovery								
Approximate raw shale size that can be processed	Minus 1/2 in.	Minus 12 in.	3 - 1/2 in.		3 - 1/2 in.	Minus 1/2 in.	3 - 1/2 in.	
Some carbon in processed shale is used for heating	Yes	No	Yes	No	No	No	Yes	No
Product gas quality	High Btu	Low Btu	Low Btu	High Btu	High Btu	High Btu	Low Btu	High Btu
Estimated yields/ton of raw shale								
Oil (% of Fischer assay)	100	90	95	100	100	100	90	100
Gas (1,000 Btu/ton)	800	500	650	550	600	700	1,000	1,000
Environmental considerations								
Processed shale	In the retorting of oil shale, the chief environmental problems are caused by the processed shale produced during retorting. These problems are similar for all retorting processes — leaching of salts at the disposal site, trace metals in the shale, shale permeability, compaction properties of the shale, and the stability of the shale pile — but they are more severe with finer particles. For a full discussion see Parts 4 and 5.							
Product gas and crude shale oil	For a discussion of product gas and crude shale oil, see Section 7.8, "Shale Oil Upgrading."							
Dust	Dust control will be required in each of the retort facilities. Those processirg finely graded shale are expected to have more severe dusting problems.							
Water consumption	The difference in water consumption between retorts is negligible, except that fines-type retorts should require more water for dust control.							

This system would require less equipment, with consequent less cost and increased reliability. On the other hand, the system would enclose and transmit dust-laden air over a much wider area, and could make it difficult to wet (and, hence, cool) the processed shale adequately and to suppress dust of all materials.

7.7.3.2 Air Cooling on Moving Grates

This method would use equipment similar to cement plant clinker coolers. Material leaving the retorts would be spread out on a moving metal grate through which air is blown upward to cool the material. Dust-laden air produced in this step would be contained in a totally enclosed system and moved, as before, to high-efficiency wet scrubbers and ancillary equipment. The cooled shale would be moisturized at the end of the cooling activity to suppress dust.

The advantage of this system is that it would use mainly air, thus minimizing water requirements. Its disadvantages would be due to the size of the equipment (which could take up much more room than a rotating-drum system) and from the higher costs and reduced reliability associated with more mechanized equipment.

7.7.3.3 Rotary-Drum Cooler

In this method, processed shale leaving the retorts would be conveyed to rotary moisturizing drum coolers, where its temperature would be reduced by tumbling and by water sprays. Dust-laden steam and moist air produced in this step would pass in an enclosed system from each drum to its own high-efficiency wet scrubber. Additional water would be added en route if necessary by venturi hydraulics. The scrubbers would condense steam and remove dust.

There are four main advantages to a rotary-drum cooling system:

- The possible variables in this system would ensure that any reasonable temperature could be achieved for processed shale en route to disposal.
- An intimate mixing of water and material could be guaranteed.
- The shorter distances required to ensure cooling would simplify layout with respect to other equipment.
- The necessity for enclosing all conveyor systems would be eliminated.

The above advantages, however, would be achieved at the price of higher equipment, maintenance, and operating costs.

7.7.3.4 Selection Rationale

On the basis of information available at this time, White River Shale Project has selected the rotary-drum cooler as the alternative to be used in the most probable plan.

7.7.3.5 Future Investigation

Extensive studies will be conducted during the single retort operation phase, and the practical information developed may change the preference stated above. Cooling on belts, air cooling on grates, or a combination of these methods may emerge as the most advantageous way to cool the processed shale. Or perhaps it may not be necessary to cool the shale at all after it leaves the retort.

It appears that a temperature in the range of 100°F to 150°F for the processed shale is reasonable. Further technical studies are now being conducted to define an acceptable temperature for processed shale when it reaches the disposal site. Should a lower temperature be required than is now anticipated, it can be achieved by augmented spraying and tumbling in the moisturizer drums without any change in process.

Section 7.8

Section 7.8

UPGRADING

In this section, the spectrum of upgrading technology available in demonstrated form is related to a range of final product oil qualities; the characteristics of these technological alternatives, as applicable to White River Shale Project, are defined; and a selection rationale leading to a preferred upgrading scheme is set forth.

7.8.1 RANGE OF UPGRADING ALTERNATIVES

Oil shale retorting yields a viscous, waxy, high-nitrogen, and high-sulfur crude shale oil that probably must be upgraded, depending upon its final use. In addition, there is retort gas to be processed, which serves as fuel for the White River Shale Project and, in some of the alternatives, as raw material for manufacture of hydrogen or for possible export from the plant site. The upgrading alternatives can be grouped according to the severity or intensity of processing, with the more severe operations resulting in the greatest change of shale oil characteristics. All of these processing schemes are available in demonstrated form from a number of licensors.

Four product oil quality objectives, which are achieved by varying degrees of upgrading, are described in this section. They are as follows:

Upgrading	Product Quality
None	Crude shale oil not readily transported by pipeline
Mild	A cracked shale oil more suitable for transport by pipeline
Moderate	Suitable as boiler fuel or refinery feedstock
Severe	High-quality refinery feedstock

These options are shown in Figure 7.8-1 in order of increasing severity of processing. Note that the options result in eight different upgrading schemes.

7.8.2 NO UPGRADING

No upgrading need be performed at the site; the crude shale oil can simply be shipped without modification to some offsite refinery for processing or to other available markets (Figure 7.8-2).

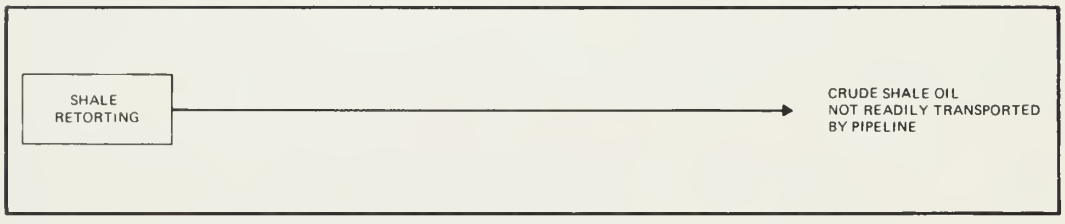


Figure 7.8-2. Shipping the Crude Shale Oil to a Refinery

This option has at least one major drawback: since the crude shale oil has a high pour point* (about 90°F) and a high viscosity**, it is not readily transported by pipeline. To enable the oil to flow at all, it is necessary either to heat the pipeline or to add a pour point depressant to the oil. Even when this is done, the oil will still be very viscous and will require relatively high pump power.

7.8.3 MILD UPGRADING

The second option is to produce cracked shale oil (Figure 7.8-3) that can more readily be pipelined to a refinery for further processing to ultimate products. Shale oil can be cracked by visbreaking, by delayed coking, or by heavy oil cracking and hydrostabilization.

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* The lowest temperature at which a specific liquid will flow

** The measure of internal friction of resistivity to flow of a liquid

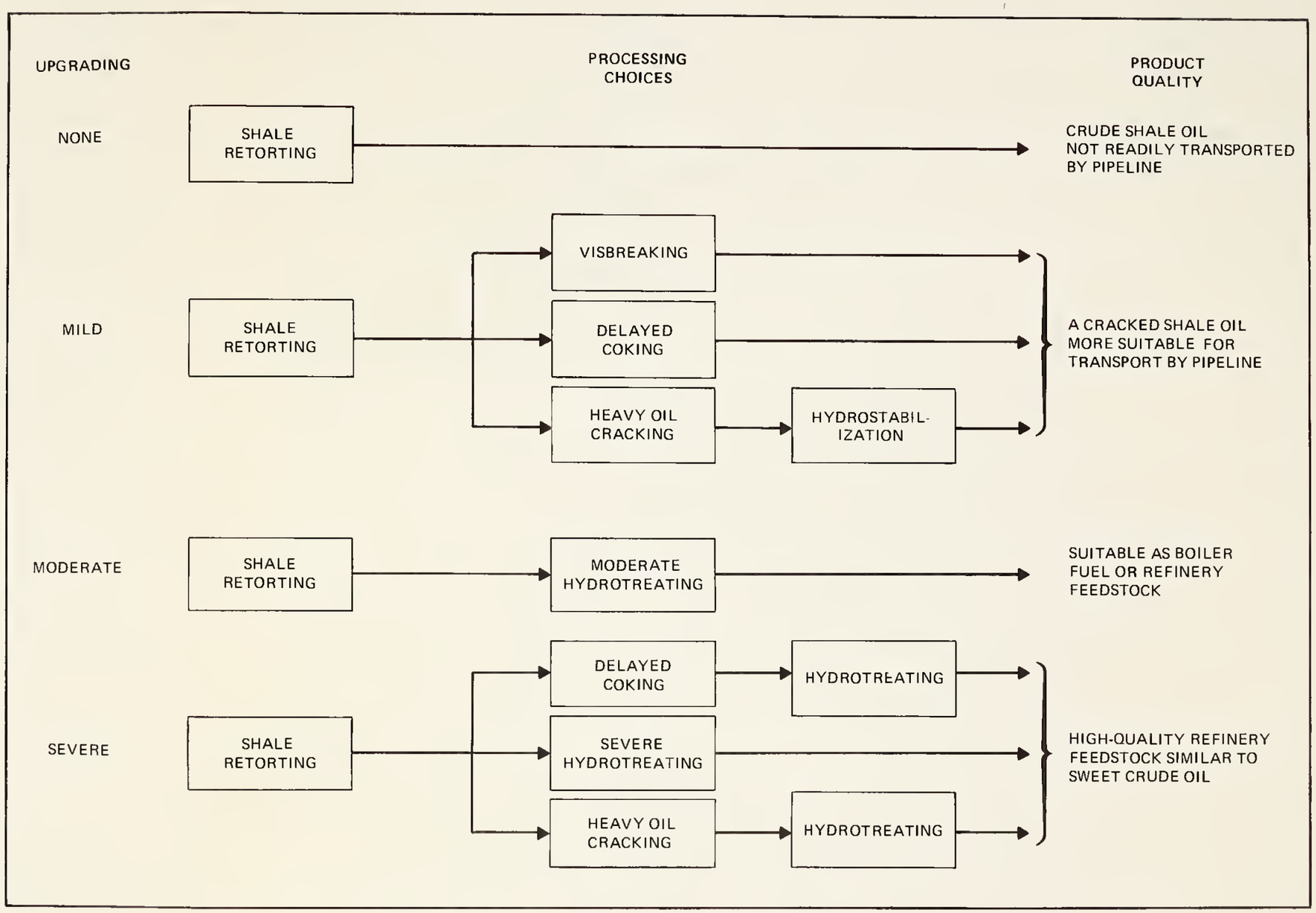

Figure 7.8-1. Upgrading Alternatives

Visbreaking, delayed coking, and heavy oil cracking plus hydrostabilization are all processes in which the large hydrocarbon molecules of the crude shale oil are cracked (broken down into smaller molecules with lower boiling points). In visbreaking and delayed coking, the cracking is accomplished entirely by heat; in heavy oil cracking, it is accomplished by means of heat and a catalyst. All three processes sharply lower the pour point of the crude shale oil (e.g., from 90°F to 35°F), but since none of these processes significantly decreases the sulfur or nitrogen content of the crude shale oil, the cracked shale oil produced must be sent to a refinery for further processing if other markets are not available.

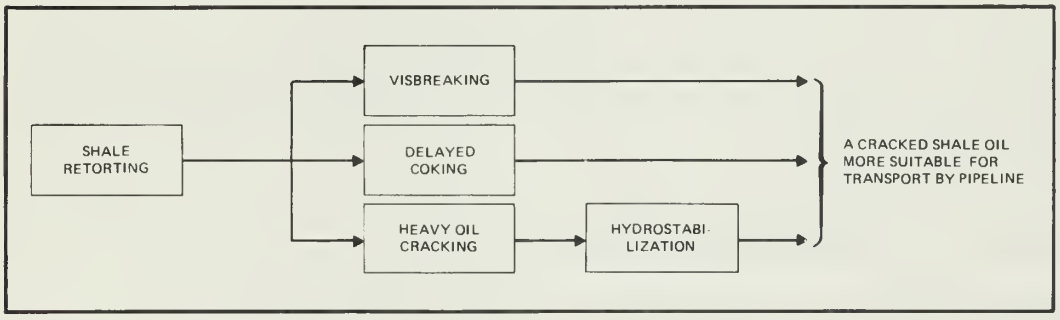

Figure 7.8-3. Processing the Crude Shale Oil to Produce Cracked Shale Oil

7.8.3.1 Visbreaking

Visbreaking is a mild thermal cracking process which lowers the molecular weights of the hydrocarbon molecules only slightly. Although the process reduces the pour point of the crude shale oil, in this instance it has little effect on the viscosity. (Hence, here the term "visbreaking" is a misnomer.)

7.8.3.2 Delayed Coking

Delayed coking is a semicontinuous thermal cracking process that produces a lower molecular weight distillate and a solid residue called coke. The distillate is the cracked shale oil. It has a low pour point and low viscosity.

7.8.3.3 Heavy Oil Cracking plus Hydrostabilization

As is the case with the delayed coking, heavy oil cracking produces both lower molecular weight distillate and a coke residue, which deposits on the catalyst. In the heavy oil cracking process, however, the coke is burned off the catalyst and the combustion heat is recovered by producing steam. The distillate is chemically stabilized by bringing it into contact with hydrogen. The resultant cracked shale oil is similar in its properties to the cracked shale oil produced by the delayed coking process just described.

7.8.4 MODERATE UPGRADING

The third option (Figure 7.8-4) is to moderately hydrotreat the crude shale oil. In the process of hydrotreating, the crude shale oil is brought into contact with hydrogen in the presence of a catalyst, the result of which is to remove the bulk of the sulfur, nitrogen, and oxygen from the oil. The process resembles the hydrostabilization process described above, except that here the consumption of hydrogen is greater. The resulting product has a pour point of $50^{\circ}F$ to $60^{\circ}F$, has a low viscosity, and is low in both sulfur and nitrogen. It can be burned in a boiler and meet federal nitrogen and sulfur specifications (no stack gas treatment is necessary), or it can be sent to a refinery for further processing.

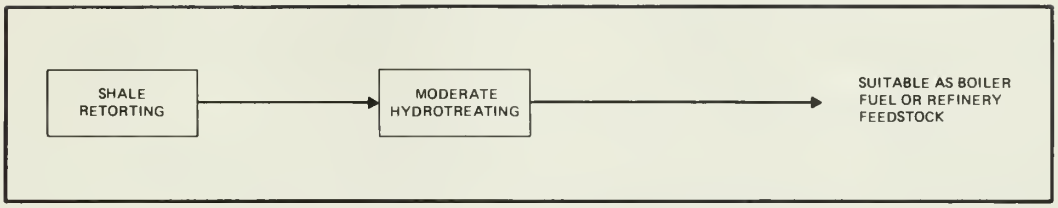

Figure 7.8-4. Processing the Crude Shale Oil to Produce Boiler Fuel Oil

7.8.5 SEVERE UPGRADING

The most complete type of upgrading – converting the crude shale oil to a high-quality refinery feedstock similar to a low-sulfur crude oil – is shown in Figure 7.8-5. Three methods of obtaining this product are shown. Each method produces an oil that has a low pour point (about 35°F) and a low viscosity, and that is low in both sulfur and nitrogen. The upgraded shale oil produced is suitable for pipelining to, and further processing in, domestic petroleum refineries for conversion to a full range of products.

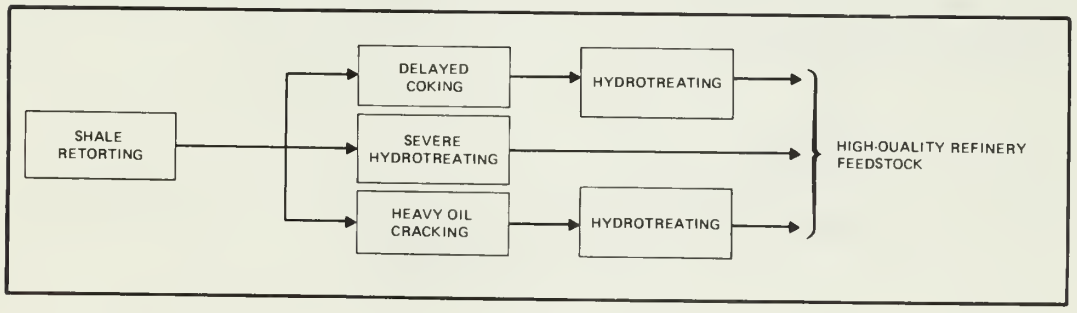

Figure 7.8-5. Processing the Crude Shale Oil to Refined Shale Oil

7.8.5.1 Delayed Coking plus Hydrotreating

The first option, a combination of delayed coking and hydrotreating, uses the processes described above.

7.8.5.2 Severe Hydrotreating

The hydrotreating process that directly converts the crude shale oil to upgraded shale oil is a much more severe form of hydrotreating than the one used to make a boiler fuel quality oil. This method of upgrading the crude shale oil produces a better oil than the other severe processing schemes.

7.8.5.3 Heavy Oil Cracking plus Hydrotreating

This alternative combines the processes described above.

7.8.6 UPGRADING SUMMARY

The most significant facts concerning the shale oil upgrading schemes are presented in Tables 7.8-1 and 7.8-2, and discussed below.

7.8.6.1 Product Oil Quality

The product oil qualities are as discussed in each process section and as footnoted in Table 7.8-1.

7.8.6.2 Retorting

All the alternatives described herein assume the use of a combination of 20 vertical-type retorts and 3 fines-type retorts.

7.8.6.3 Product Oil, BPCD

Product oil output ranges from 87,020 to 100,300 BPCD, as shown in Table 7.8-1.

Table 7.8-1

SUMMARY OF THE EIGHT SHALE OIL UPGRADING SCHEMES

Oil Product Quality[a]	Upgrading Scheme		No. of Retorts			Product Oil, BPCD	Thermal Efficiency Disregarding Quality Differences %
			Vertical Type		Fines Type		
			DH	IH			
4	None	Crude shale oil	20	0	3	100,000	77.2[b]
3	Mild	Visbreaking	20	0	3	100,300	75.6
3		Delayed coking	20	0	3	89.500	75.1
3		Heavy oil cracking hydrostabilization	20	0	3	93.600	75.5
2	Moderate	Hydrotreating	17	3	3	96,000	71.3
1	Severe	Delayed coking hydrotreating	20	0	3	87,020	69.1
1		Severe hydrotreating	17	3	3	96,000	69.8
1		Heavy oil cracking hydrotreating	20	0	3	87,930	71.4

(a) Oil product quality:
1. High-quality refinery feedstock; lowest in nitrogen and sulfur
2. Boiler fuel quality; low in nitrogen and sulfur
3. Cracked shale oil; still high in nitrogen and sulfur; readily transported by pipeline
4. Crude shale oil; high in nitrogen and sulfur; not readily transported by pipeline

(b) Thermal efficiencies are for Option A; see Subsection 7.8.6.5.

7.8.6.4 Thermal Efficiency

Thermal efficiencies for onsite production of various quality oils fall in the range 69.1 to 77.2 percent, as shown in Table 7.8-1.

7.8.6.5 Power Export Potential

Each of the eight alternatives can be developed in any one of three ways: Option A, Option B, or Option C, as footnoted in Table 7.8-2.

- Option A – All surplus fuel and steam are converted to electric power in a utility plant. Power in excess of that required for the oil shale facility is exported.
- Option B – The utility plant is sized only large enough to satisfy the power requirements for the oil shale facility. The utility plant includes sufficient spare equipment to preclude reliance on an outside power source. Fuel in excess of that needed in the utility plant is exported.
- Option C – There is no utility plant. The power required for the oil shale facility is purchased. All surplus fuel and steam are exported.

In six upgrading alternatives, some electric power is exported. In the other two alternatives, there is no power in excess of that required for the oil shale facility.

7.8.6.6 Fuel Export Potential

As shown in Table 7.8-2, the major fuel exports are low-Btu gas, coke, and steam.

7.8.6.7 Environmental Effects

The following broad questions should be considered during evaluation of environmental effects of the eight upgrading alternatives:

- What is the environmental effect of energy export or flaring of significant quantities of non-shale-oil energy?
- What is the environmental effect of generating electrical power on tract beyond requirements and exporting the excess?
- What are the environmental effects on tract of the alternative schemes?

The answers to these questions are summarized in Table 7.8-3 and further discussed in Subsection 7.8.8, "Selection Rationale."

As shown in Table 7.8-4, the on-tract environmental effects are related very closely to the severity of upgrading. As the crude shale oil is refined more completely, increasing quantities of sulfur and nitrogen are removed from it and are recovered as elemental sulfur and ammonia, both useful chemical commodities.

As upgrading severity increases, so do the requirements for raw water and fuel for boilers and fired heaters, as shown in Table 7.8-4. This is an effect and a cost that must be recognized as a part of shale oil recovery and refining.

With respect to the on-tract effects on air quality, the significant environmental impacts result from combustion of coke containing nitrogen to an extent that would cause NO_x emissions in the flue gas, with no satisfactorily demonstrated large-scale technology presently available for correction of the problem. These cases show up with black boxes in the "Air" column in Table 7.8-3. In contrast, in other altenatives the flue gases, which result from burning scrubbed fuel gases, do not present such a problem.

Table 7.8-2

EXPORT QUANTITIES PRODUCED
BY UPGRADING SCHEMES

Alternative: Fuel – Process Quality	Upgrading Scheme		Options*	Export Quantities: Electrical Power	Coke	Gas: Low Btu	Gas: High Btu	Steam	Fuel Oil
				MW	Billion Btu/CD				
4 – CSO	None	Crude shale oil	A	136	0	0	0	0	0
			B	0	0	42.3	0	0	0
			C	0	0	88.7	0	0	0
3 – VIS	Mild	Visbreaking	A	95	0	0	0	0	0
			B	0	0	28.1	1.7	0	0
			C	0	0	73.2	1.7	0	0
3 – DC		Delayed coking	A	350	0	0	0	0	0
			B	0	72.6	36.7	0	0	0
			C	0	72.6	80.6	0	0	0
3 – HOC-HS		Heavy oil cracking hydrotreating	A	332	0	0	0	0	0
			B	0	0	87.4	9.3	0	6.9
			C	0	0	89.6	9.3	41.0	6.9
2 – HT	Moderate	Hydrotreating	A	0	0	0	0	0	0
			B	0	0	0	0	0	0
			C	0	0	57.7	0	0	0
1 – DC-HT	Severe	Delayed coking hydrotreating	A	200	0	0	0	0	0
			B	0	62.6	0	0	0	0
			C	0	67.6	57.7	0	0	0
1 – HT		Severe hydrotreating	A	0	0	0	0	0	0
			B	0	0	0	0	0	0
			C	0	0	55.2	0	0	0
1 – HOC-HT		Heavy oil cracking hydrotreating	A	244	0	0	0	0	0
			B	0	0	69.3	0	0	6.9
			C	0	0	82.8	0	41.0	6.9

*Options (Refer to Subsection 7.8.6.5)

A. Surplus fuel and steam converted to electrical power for export
B. Beyond internal power requirement, surplus fuel and steam exported
C. No power generated; net fuel and steam exported

Table 7.8-3

SHALE OIL UPGRADING SCHEMES
SUMMARY OF ENVIRONMENTAL EFFECTS

ALTERNATIVE FUEL PROCESS QUALITY [a]	UPGRADING SCHEME		ELECTRICAL GENERATION OPTIONS [b]	ENERGY EXPORT [c]		CUMULATIVE ENVIRONMENTAL EFFECTS ON TRACTS [c]		
				GAS/STEAM	ELECTRICITY	AIR	WATER	SOLID
4 – CSO	None	CRUDE SHALE OIL	A[d]		■	□	□	□
			B	■		□	□	□
			C	■		□	□	□
3 – VIS	Mild	VISBREAKING	A[d]		■	▒	▒	□
			B	■		▒	▒	□
			C	■		▒	▒	□
3 – OC		DELAYED COKING	A		■	■	■	▒
			B	■		▒	■	▒
			C	■		▒	■	▒
3 – HOC-HS		HEAVY OIL CRACKING HYOROSTABILIZATION	A		■	■	■	▒
			B	■		■	■	▒
			C	■		■	■	▒
2 – HT	Moderate	HYDROTREATING	A			▒	▒	□
			B			▒	▒	□
			C	■		▒	▒	□
1 – DC-HT	Severe	DELAYED COKING HYDROTREATING	A		■	■	■	▒
			B			▒	■	▒
			C	■		▒	■	▒
1 – HT		SEVERE HYDROTREATING	A			▒	▒	□
			B			▒	▒	□
			C	■		▒	▒	□
1 – HOC-HT		HEAVY OIL CRACKING HYDROTREATING	A		■	■	■	▒
			B	■		■	■	▒
			C	■		■	■	▒

(a) **FUEL QUALITY**

1. High-quality refinery feedstock; lowest in nitrogen and sulfur
2. Boiler fuel quality; low in nitrogen and sulfur
3. Cracked shale oil; still high in nitrogen and sulfur; readily transported by pipeline
4. Crude shale oil; high in nitrogen and sulfur; not readily transported by pipeline

(b) **ELECTRICAL GENERATION OPTION**

Option A. All surplus fuel and steam are converted to electric power in a utility plant. Power in excess of that required for the oil shale facility is exported.

Option B. The utility plant is sized only large enough to satisfy the power requirements for the oil shale facility. The utility plant includes sufficient spare equipment to preclude reliance on an outside power source. Fuel in excess of that needed in the utility plant is exported.

Option C. There is no utility plant. The power required for the oil shale facility is purchased. All surplus fuel and steam are exported.

(c) **LEGEND**

□ Minimal on-tract effects

▒ Controllable to meet state and federal pollution control regulations

■ Significant environmental impacts or implications

(d) **FURTHER DISCOUNTED; REFER TO SUBSECTION 7.8.8.3**

(e) **FURTHER ANALYSIS IN SUBSECTION 7.8.8, "SECTION RATIONALE"**

Table 7.8-4

ON-TRACT ENVIRONMENTAL EFFECTS,
OPTION B – BALANCED ELECTRICAL GENERATION

Alternative	Production, TPCD			Raw Water Use, gpm	Fuel Consumed Billion Btu/CD
Fuel Quality – Process	S	NH_3	Coke		
4 – CSO	0	0	0	4,010	64
3 – VIS	33	0	0	4,010	78
3 – DC	36	0	2,422 0	4,350	88 34
3 – HOC-HS	52	0	(2,100)[a]	4,860	(60)[a]
2 – HT	163	370	0	5,790	184
1 – DC-HT	136	290	2,256	5,910	190
1 – HT	165	412	0	5,960[b]	198
1 – HOC-HT	129	274	0 (2,100)[a]	5,900	107 (60)[a]

(a) Coke burned in the HOC regenerator
(b) Raw water as shown in the water balances in Figure 3.15-2

Significant on-tract effects on water quality will arise from coking and heavy-oil cracking process water streams that contain chemical compounds – such as phenols, cyanides, and other nonstrippable materials – that are very difficult to remove with existing technology. In Table 7.8-3, these are represented as black boxes in the "Water" column. On the other hand, process water from other alternatives contains principally hydrogen sulfide and ammonia and since both these compounds are easily strippable, the water can be reused.

No solid handling problems arise that cannot be controlled easily. This fact is especially apparent when these solids are compared with the large amounts of processed shale.

7.8.7 MINOR AND SUPPORT PROCESSES

These processes serve the essential purpose of separating the output streams of the primary processes described above into useful components and of removing contaminants (sulfur and nitrogen) from them for environmental protection. In general, these processes are proven, standardized methods with only very minor alternative features.

7.8.7.1 Light Ends Processing

In all of the alternatives, there are two basic types of process gas streams to be considered: a low-Btu gas to be used as fuel, and a high-Btu gas to be separated into specific components. They are processed separately.

7.8.7.2 Low-Btu Gas

Typically, this is gas from the vertical-type DH retort. It contains a high proportion of nitrogen, as well as small quantities of hydrogen sulfide and ammonia. These latter components are removed and recovered in a sequence of operations: water washing and passage through a Stretford sulfur plant. The treated gas is suitable for use as fuel since the resultant flue gas will meet the relevant federal and state code requirements. For further discussion, see Part 4 of this DDP.

7.8.7.3 High-Btu Gas

Typically, this is gas from the IH type retorts or other upgrading processes, such as visbreaking, coking, or cracking. It contains components that have specific use in the overall upgrading schemes, as well as quantities of sulfur compounds that must be removed. An amine scrubbing process removes hydrogen sulfide and small quantities of carbon dioxide. The hydrogen sulfide is converted to elemental sulfur in a Claus sulfur plant, and the carbon dioxide is discarded to the atmosphere.

The remaining hydrocarbons are separated by absorption and distillation into components suitable for use as hydrogen plant feedstock and as additions to the product oil stream.

7.8.7.4 Hydrogen Production

In those alternative upgrading schemes that use hydrogen to improve product oil quality, the required quantities of light hydrocarbons (preferably propane and butane) are passed through a bed of catalyst along with steam at elevated temperature and pressure. The alternative choices for this process relate to refinements in catalysts and in operating procedures.

7.8.7.5 Wastewater Treating

The wastewaters from contacting and scrubbing operations are treated for removal and recovery of contaminants by methods described fully in Sections 3.15 and 7.15 and in Part 4.

7.8.7.6 Sulfur

The sulfur recovered in the Claus sulfur plant varies from 33 to 165 tons per day, depending on the specific alternative upgrading scheme. It will be of marketable quality and will serve fertilizer and industrial purposes.

The Stretford sulfur recovered from treating low-Btu gas is a minor quantity (about 50 tons per day) and is of inferior quality. It will be disposed of with the processed shale if other outlets are not available.

7.8.7.7 Ammonia

The quantity of ammonia recovered varies from 274 to 412 tons per day for those alternatives using hydrogen processing; none is recovered in

the other schemes. It is of marketable quality and could serve the fertilizer industry.

7.8.8 SELECTION RATIONALE

7.8.8.1 Gas/Steam Export Potential

There are eight alternative upgrading possibilities to be considered, with three electrical power generation choices for each. Of these 24 cases, 13 require export from the tract or flaring of significant quantities of gas (principally low-Btu gas) or steam, as shown in Table 7.8-2. The quantities are much too large to flare without adverse effects on resources recovery, but are too small to be transported economically to any existing point of use. Thus, in the broadest sense, these 13 alternatives must be discounted because of a poor use of an available resource. These cases are identified in Table 7.8-3 with a black box.

This leaves 11 cases for further consideration.

7.8.8.2 Electricity Export Potential

The combustion of oil for the generation of electrical power to be exported, with its attendant loss of efficiency, does not seem appropriate since there are other alternatives available. Thus, 6 of the remaining 11 alternatives from Subsection 7.8.8.1 must be discounted to some degree.

Four of these six cases (delayed coking and heavy oil cracking cases) are further discounted because of the on-tract effects of NO_x produced by combustion of coke using current combustion technology and the difficulty of reclaiming water for reuse, as discussed in Subsection 7.8.6.7. These discounts show as black boxes in Table 7.8-4 in the "Electricity," "Air," and "Water" columns.

These latter four cases are eliminated from further evaluation.

7.8.8.3 Additional Considerations

Referring to Table 7.8-3, seven cases remain as potential choices. They are summarized in Table 7.8-5.

Table 7.8-5

SUMMARY OF SEVEN POTENTIAL CHOICES

Option	Process
A	Crude shale oil
A	Visbreaking
A	Hydrotreating (moderate)
B	Hydrotreating (moderate)
B	Delayed coking-hydrotreating
A	Hydrotreating (severe)
B	Hydrotreating (severe)

Of these seven cases, the A-crude shale oil and A-visbreaking cases are further discounted because of the impracticality of transporting these high-pour point, high-viscosity oils without the use of heated pipelines and because of the high power requirements for pumping.

Of the five remaining cases, the B-delayed coking-hydrotreating case must be discounted because of the present impracticality of exporting large quantities of coke from the tract to the nearest railroad.

7.8.9 CONCLUSIONS

Consideration of the foregoing rationale makes obvious that any choice involves some compromises. On balance, it appears that logical choices rank as follows:

Choice	Alternative
First	Hydrotreating (severe)
Second	Hydrotreating (mild)

with only a minor preference for the first choice over the second.

These two alternatives, and possible a limited number of the others, could easily be given future consideration as the candidate for actual installation by White River Shale Project, especially in view of the continuing rapid pace of retorting and upgrading technology development.

At this time, White River Shale Project has selected the alternative of severe hydrotreating as the most probable path for upgrading.

Section 7.9

Section 7.9

SOILS HANDLING

The alternatives for soils handling are described in this section. Advantages and disadvantages of the alternatives are evaluated and compared with selection criteria.

7.9.1 ALTERNATIVE METHODS

Earth-moving activities involving cuts, fills, and grading for process areas are required for each phase of construction for the White River Shale Project. Cuts and fills are balanced as much as possible for each construction phase, producing a minimum of excess material.

Two major alternatives are considered for disposal of excess amounts of cut material:

- Depositing all excess soil and rock in Southam Canyon along with the processed shale
- Filling in sites near each excavation activity

The proposed plan is explained in detail in Section 3.9.

7.9.2 EVALUATION OF ALTERNATIVE

Excess material disposal in Southam Canyon with the processed shale is preferred to depositing it in numerous small landfills near each excavation. Southam Canyon is judged to be large enough and adequate for such disposal. As indicated in Table 7.9-1, disposal in Southam Canyon will require longer truck hauls but will result in fewer disturbed areas and, therefore, less rehabilitation and less impact on the environment.

Table 7.9-1

EXCESS SOILS HANDLING ALTERNATIVE EVALUATION

Selection Criteria	Disposal in Southam Canyon With Processed Shale (Proposed Plan)	Disposal in Many Landfills Close to Excavations (Alternative Plan)
Areas of Disturbance	One small area outside Southam Canyon, In Southam Canyon, no additional disturbance. Fewer adverse environmental impacts	Many small landfills close to excavations. More adverse environmental impacts
Requirements for Surface Rehabilitation	One site in addition to Southam Canyon (see Section 3.9). No change in rehabiltation plans for Southam Canyon	Many small landfills, needing rehabilitation, each involving erosion controls, slope stability considerations, and revegetation
Logistics of Disposal	Longer truck hauls, but no additional truckloads. No interference with processed shale disposal	Shorter truck hauls
Aesthetics	One new landfill (see Section 3.9) can be seen. No aesthetic change on processed shale disposal in Southam Canyon	Many small landfills throughout the area having greater adverse aesthetic effects
Economics	Longer truck hauls. Less rehabilitation activity required	More rehabilitation activity. Shorter truck hauls

Section 7.10

Section 7.10

PROCESSED AND RAW SHALE DISPOSITION

7.10.1 INTRODUCTION AND OVERVIEW

Whatever methods are used to mine and retort the oil shale, the resulting processed shale must be disposed of in an environmentally acceptable place and manner. The most probable disposal plan is discussed in Section 3.10. Alternative dispoal sites, fill plans, water and dust control systems, and revegetation programs for Phases II, III, and IV are examined in this section. The alternatives are evaluated and the selection rationale presented.

Water management is especially important in connection with processed shale disposal. Approximately 5,300 acres of drainage to the White River (and, ultimately, to the Colorado River) could be affected by the project. An integrated system of water control and conveyance must be designed to accomplish the following goals:

- No contamination of natural waterways
- No or limited erosion of the terrain
- Maximum use of drainage water for revegetation and other project uses

The drainage features and control measures for various phases of the project will include dams, ditches, stabilizing techniques, seepage control measures, surface contouring, and revegetation.

7.10.2 CHARACTERISTICS OF PROCESSED SHALE

On the basis of laboratory-scale processing, shale from Tracts U-a and U-b is assumed to be similar to Colorado shale that has been processed in a Paraho retort. Woodward-Clyde Consultants (Ref. 36) tests on the latter material are tabulated in Section 3.10. Generally, the processed shale is expected to be a coarse, gravel-like substance, gray-to-black in color, that is dusty and easily crumbled.

The processed shale will have increased in bulk volume some 20 percent over the original in-place material mined. A density of 85 pounds per cubic foot has been selected as a working figure based on Woodward-Clyde tests and upon expected compaction by trucks and by the shale itself as the pile enlarges.

Thus, the very nature of processed oil shale presents two problems to the environment: dust and disposal. Dust control is discussed briefly in this section and at length in Section 4.2. A sound disposal plan must provide not only adequate physical space to hold the 950,000,000 cubic yards of processed shale expected over the life of the project, but it must ensure that salts and other undesirable substances do not contaminate groundwater or the White River. The completed pile will be revegetated to blend in with existing topography and to support the kinds and amounts of animal life that live there now. It is also desirable that the revegetation program begin early in the project and proceed on a continuous basis; this requirement influences the method of placing the shale.

7.10.3 POSSIBLE DISPOSAL SITES

Possible repositories for the processed shale include all of Southam Canyon (on and off tract), Evacuation Creek, Canyon "G," and the on-tract part of Southam Canyon. The advantages and disadvantages of each are discussed in the following paragraphs.

7.10.3.1 Off Tract

The southern off-tract part of Southam Canyon was briefly considered in combination with filling the remaining on-tract portion of the canyon. The advantages include gaining more space for disposal, eliminating the possibility of water accumulating in the canyon behind the shale pile and the necessity of either building a dam there or sealing the southern slope of the shale pile, and allowing more natural drainage to the White River. However, the lease stipulates that all waste material be disposed of within the tract boundaries.

7.10.3.2 Evacuation Creek

Evacuation Creek is less desirable as a processed shale disposal area for several reasons. It runs through Tract U-b from south to north, but only a small portion (5-1/2 square miles) of this stream's 290 square mile watershed is within the tract. The excessive size of this watershed would require an extensive drainage control system.

The creek has an on-tract volume (to the ridge tops) of approximately 830 million cubic yards. To contain the entire 20-year production of processed shale, the canyon would have to be filled 20 feet above the ridge tops.

A third factor tending to disqualify Evacuation Creek as a disposal area is the 100-foot-thick Bird's Nest Aquifer exposed near the present creek bed. It would be a continual source of leachate and would be in danger of contamination from salts in the processed shale.

7.10.3.3 Canyon "G"

Canyon "G" lies directly west of the processing area, as shown in Figure 7.10-1, and is considered as a disposal site only for processed shale from Phase II. Its 40 million cubic yard capacity would not accommodate Phases III and IV processed shale, but would be more

than adequate for the estimated 4-1/2 million cubic yards resulting from Phase II. The advantages this site would have over Southam Canyon are its nearness to the processing area and its ability to serve as a temporary dump site if the conveyor fails in Southam Canyon. The disadvantage would stem from having two separate processed shale piles if the project goes beyond Phase II.

7.10.3.4 Underground (Mine)

Underground disposal of processed shale is usually a more environmentally acceptable method than surface disposal. However, there are many technical problems that must be considered.

- The mine openings will only hold about 60 to 70 percent of the total, and therefore a significant portion of processed shale must be disposed of on the surface.

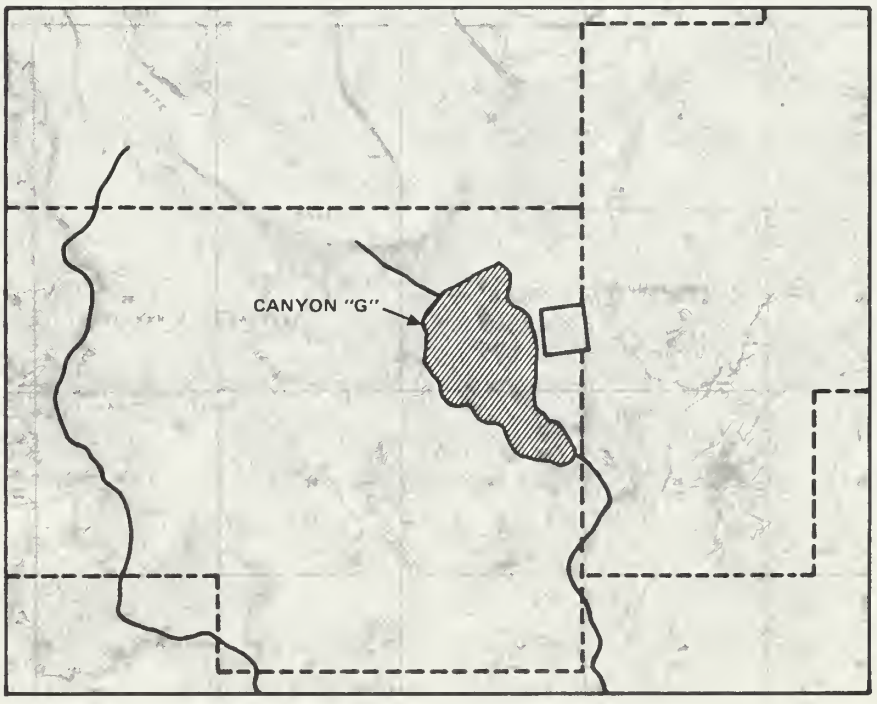

Figure 7.10-1. Canyon "G"

- Bureau of Mines test work shows that oil shale has a high coefficient of thermal expansion. Therefore, if hot processed shale is placed underground, it will tend to lower the vertical compressive strength of the support pillars, which could reduce the overall percent of ore recovery.
- Underground placement of processed shale into worked-out panels is technically feasible, but it is more complex and much more costly than surface disposal. Dust is a major problem.
- With presently known methods, secondary recovery of the remaining support pillars and lower grade oil shale in the mine floor and roof, either by in-situ or conventional mining methods, would be extremely difficult if the underground openings were filled with processed shale.

The above problems need not preclude the possible eventual disposal of processed shale in the mine, but it is felt that WRSP must proceed with surface disposal until such time as the technical and economic viability of underground disposal is assured. WRSP will continue to evaluate this method of processed shale disposal as the leases are developed.

7.10.3.5 Southam Canyon

The most probable plan calls for all processed shale to be placed on tract in Southam Canyon. It runs from south to north through Tract U-a and has a small drainage area; the 6,600-acre watershed lies mostly (4,050 acres) within the tract. The canyon's total volume is approximately 1,400 million cubic yards, of which 940 million are on the tract. Southam Canyon can contain all the processed shale.

Although the Bird's Nest Aquifer is found beneath Southam Canyon, it is confined and under artesian conditions. Drilling tests have shown relative impermeability of the material that overlies the aquifer; hence, neither significant upward migration of water nor significant downward migration of leachate is to be expected.

7.10.3.6 Evaluation and Selection

Southam Canyon on tract emerges as the most probable choice for several reasons. It is big enough to contain all of the processed shale produced during the life of the project. The processed shale in Southam Canyon does not pose a contamination danger to the Bird's Nest Aquifer nor a problem in providing drainage control facilities. Although there are no disadvantages to Canyon "G" for the Phase II operation, it does not possess any significant advantages over Southam Canyon, except for closeness.

7.10.4 PHASE II – SINGLE RETORT OPERATION

In the single retort operation, up to 10,000 TPCD of oil shale mined will yield approximately 7,200 TPCD of processed shale and minus 1/2 inch fines that must be disposed of. The disposal area must have a volume of approximately 4.5 million cubic yards.

7.10.4.1 Fill Plan

The most probable plan calls for placing the processed shale in a side canyon on the eastern ridge of Southam Canyon, as shown in Figure 3.10-3 and as fully described in Section 3.10. A distinct advantage to both this part of Southam Canyon and Canyon "G" is that they are relatively small, discrete areas that can be completely contained and revegetated if the project should stop after Phase II. If the project does continue into Phases III and IV, the Southam Canyon Phase II area could be used both as a revegetation pilot station and as a beachhead for conveyors and for trucking activity.

7.10.4.2 Equipment

In the most probable plan, processed shale will be transported by conveyor from the retort to bins at the disposal site. There it will be loaded onto trucks and moved to the final disposal area. The only alternative

is to replace the conveyors with trucks. This is undesirable because of the increased emissions, dust, noise, energy consumption, labor, cost, etc.

7.10.4.3 Water Control and Management

The most probable plan, described in Subsection 3.10.4.2, calls for construction of a small catchment west of the shale pile to contain surface runoff from the pile. This catchment will be covered over in Phases III and IV, as described in Subsection 7.10.5. There are no real alternatives now being investigated for Phase II. If Canyon "G" is used, a catchment similar to the one described for the side arm of Southam Canyon will be required.

7.10.4.4 Dust Control

Dust control programs, detailed in Section 4.2, consist of enclosing conveyors and dust-generating points, wetting, and stabilization. Chemical wetting agents will be used only if absolutely necessary.

7.10.4.5 Revegetation

The contouring and revegetation plan is described in Sections 3.10 and 4.6. Details of the program will be based on data to be developed by the Utah State University. In any case, the Phase II processed shale pile will be available for revegetation experimentation by Year 5, and experience gained will influence the Phase III and IV revegetation programs.

7.10.4.6 Evaluation and Selection

Phase II plans for shale disposal have few alternatives. There are only two possible sites, with little difference between them; Southam Canyon is preferred simply because it would form the beginning of an ongoing fill program. Possible alternative methods of handling and transporting

the material are available (as is discussed in Subsection 7.10.5.1), but their size and cost are inappropriate for Phase II.

The water control, dust control, and revegetation programs are all necessarily based on incomplete information and are subject to modification as hard data become available from actual operation. These emerging programs will create more real alternatives to be evaluated for Phases III and IV.

7.10.5 PHASES III AND IV – COMMERCIAL OPERATION

In Phase III, up to 80,000 TPCD of oil shale will be mined and in Phase IV, up to 160,000 TPCD. The processed shale from these operations will total approximately 950 million cubic yards.

7.10.5.1 Fill Plan

Several procedures for filling Southam Canyon have been proposed. The most probable, described in Subsection 3.10.5.1, calls for moving from the Phase II pile in a fanlike pattern to the south, west, and north.

The other two alternatives presently being considered include east-west berms and north-south ramps with filling proceeding either from the north end of Southam Canyon to the south or vice versa.

Starting at the North. In this disposal scheme, shown in Figure 7.10-2, a berm would be extended from east to west across the mouth of the canyon. The berm would have a 4:1, or 25 percent, compacted slope on its north face and a 5 percent slope on the south face and advancing front during building. The top of the berm would be 400 feet wide at an elevation of 5,500 feet. Southam Canyon would be filled to plateau level by a continual widening of this berm top in a southward direction, thus creating a continuous plateau rising with a 3 percent grade to

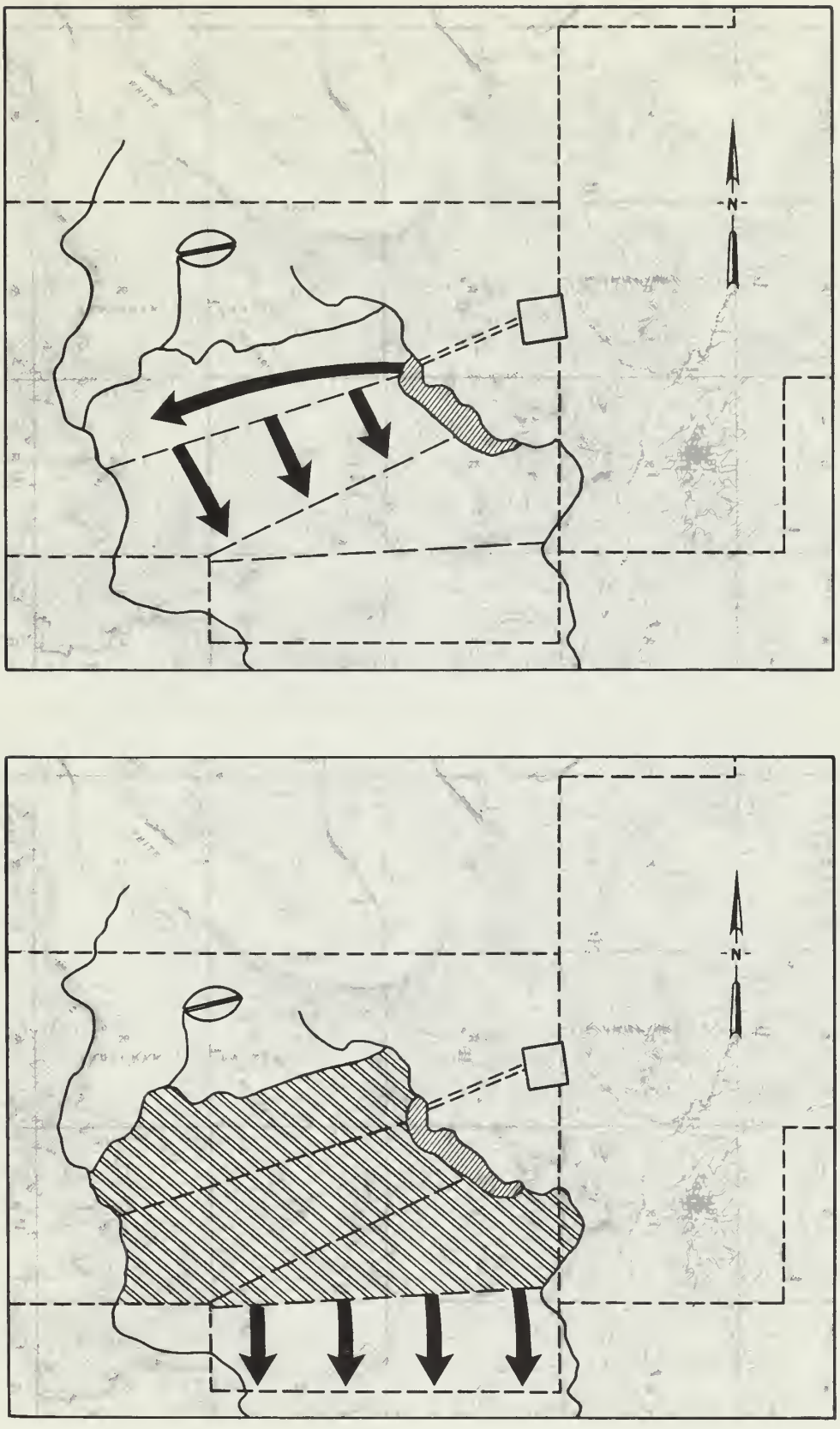

Figure 7.10-2. Fill Plan Starting at the North

5,760 feet. The surface would be contoured and revegetated as soon as possible after completion. The advantages include:

- In approximately 5 years, the north slope could be completely established as a planting area, and more area would be continuously available.
- Fewer resources would be required during initial phases of disposal work.

The disadvantages are as follows:

- Since the canyon would be completely blocked off by the berm early in the project, storm runoff would collect in the canyon or percolate through the berm, carrying a high level of dissolved salts.
- At the time the 400-foot-wide berm is ready for revegetation, the area covered by processed shale would be up to a mile wide and 1-1/2 miles long; i.e., approximately 900 acres would be disturbed before any significant revegetation could start.
- During the first 5 to 7 years, this scheme would allow the smallest ratio of vegetated to unvegetated shale area.

Starting at the South. In this disposal plan, illustrated in Figure 7.10-3, a ramp would be extended to the southeast tract limit, then the south end would be completely closed off, and the filling would proceed all the way across the canyon down to the mouth. When the northern boundary is reached, the pile will be compacted at a 4:1 slope.

The disadvantage of this method is that little area would become available for revegetation until the ramp is fully extended, which would require approximately 190×10^6 cubic yards of material or 5 years.

7.10.5.2 Equipment

Equipment for placing processed shale in Southam Canyon will be selected by balancing factors relating to the nature of the job and the characteristics

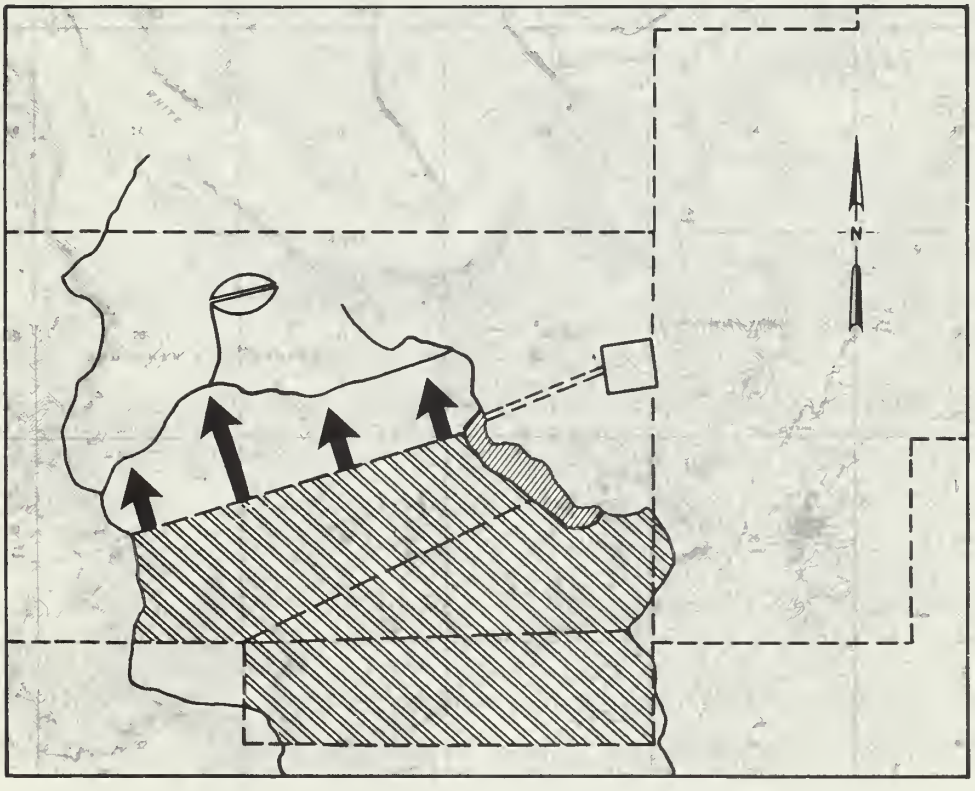

Figure 7.10-3. Fill Plan Starting at the South

of equipment alternatives available. The chief influencing factors are listed below:

- Rough terrain of Southam Canyon
- Compaction of processed shale — either by machine or by its own weight, or by both
- Reliability of equipment
- Environmental impact evaluations to the extent to which data bases are available

The means of transport investigated were conveyors, trucks, stackers, and slurry pipeline. Each is described and evaluated in the following paragraphs.

Conveyors. For the mass movement of processed shale from the retort area to Southam Canyon, covered conveyors are clearly superior to trucks and could reasonably be replaced by a slurry transport system, as is discussed later in this section.

After the shale arrives at Southam Canyon, it must be placed in the canyon. Because of the rough terrain, a conveyor system lacks the necessary flexibility for the final placing of the shale. The stacker discussed later in this section also lacks the needed flexibility.

Trucks. For operations within Southam Canyon, trucks are the only workable alternative for a significant portion of the total job. Only trucks have the flexibility of movement required to place processed shale in the wide variety of side canyons and around the many natural obstacles encountered in Southam Canyon.

Trucks have the added advantage of performing a degree of compaction during the placement of the shale. This reduces the need for specific compacting activities, which would contribute to the problems of dust, noise, and gaseous emissions.

Stackers. A stacker is a very large mechanical device capable of receiving processed shale from a conveyor and tripper and transferring it to another conveyor that runs out on a long boom capable of swinging horzontally and vertically. The stacker mechanism, on crawler-mounted tracks, is itself capable of moving and maneuvering, but only in a limited fashion because of its great size and weight. Thus, a stacker permits the position of the end of the conveyor to be moved while processed shale is being discharged.

One or more stackers could begin operation from the top of the pile formed in earlier stages of commercial operation. Terraced piles would be built cascading from top elevation down to the bottom of the canyon. Use of more than one stacker would permit continued operation during repair, maintenance, or moving of one of the stackers.

Auxiliary equipment — dozers, graders, trucks — will be needed to shape the pile, to create the finished contoured surface, and to construct ramps that will allow stackers to climb the terraces.

Advantages of using stackers rather than trucks include the following:

- Less exhaust fumes on tract because the stackers are powered by electricity
- Quieter operation than trucks
- Less congestion at loading points
- Fewer transfers of material — thus less dust
- More reliable operation in bad weather

The following disadvantages arise from the use of stackers:

- They are not as maneuverable as trucks for filling the complex topography of Southam Canyon.
- Compacting and fine sculpturing would be separate from placement and would be auxiliary equipment.

- Their technology and use are not nearly as well established as truck use in the U. S. — with consequent reliability and maintenance problems.

Stacker use merits serious consideration and will be more extensively explored when additional information becomes available during Phase II.

Slurry Pipeline Transport. For this alternative, processed shale would be converted into a slurry by mixing it with water, and the mix would then be pumped through a pipeline into Southam Canyon. This scheme has some distinct advantages, as listed here:

- There would be no dust problem — at least during the initial placement.
- The operation would be quiet and flexible.

However, there are serious disadvantages. These include the following:

- A large amount of water would be required by the slurry process even though some of the water used in the transport would be returned and reused.
- Saturating the shale would create a greater danger of groundwater contamination.
- The processed shale would require further crushing for slurry preparation, thus creating more dust in the crushing operation and augmenting the dust problem.

The overall operation, with its additional crushing, water recovery, increased water use, and potential dust problems, has been judged a less desirable alternative at this time.

7.10.5.3 Water Control and Management

The present hydrologic conditions of the Southam Canyon disposal site are discussed in the following paragraphs, followed by proposed control methods. More comprehensive information about water resources for the entire lease area is found in Section 2.3.

Groundwater. In the disposal area, groundwater is present in a complex system of shallow unconfined and deep confined aquifers. Shallow unconfined groundwater exists in the alluvium near the mouth of Southam Canyon and the White River flood plain. Spring 1975 observations found short-lived seeps from the bedding planes and fractures of the shale and siltstone of the Uinta Formation. However, onsite drilling encountered no water in the formation.

Data from the observation well program show that the Bird's Nest Aquifer table slopes to the northwest, as does the geologic structure.

The Bird's Nest Aquifer, found in the upper part of the Green River Formation, is the aquifer of primary concern in the disposal area. Its thickness ranges from 90 to 200 feet and averages approximately 115 feet. Beneath Tract U-a, it is deeply buried under approximately 500 feet of interbedded sandstone and shale, and there are no known discharge points on the tract.

The aquifer has been penetrated by 41 boreholes in Tracts U-a and U-b and yielded water to wells at rates ranging from 550 gpm near the northwest corner of Tract U-a to 3 gpm at the southern boundary of the project area.

Conditions for recharge are poor because annual rainfall amounts to approximately 8 inches, and the overlying, relatively impervious Uinta Formation prevents even that from reaching the aquifer. Evacuation Creek is a potential area for recharge where the aquifer is in contact with alluvium along some of the canyons.

Because of the physical characteristics of the pile and the impermeability of the Uinta Formation, the Bird's Nest Aquifer is not expected to become contaminated by seepage through the processed shale materials.

Surface Runoff. In the most probable plan, a retention dam will be constructed near the mouth of Southam Canyon (see Figure 3.10-5) to prevent contaminated surface runoff from the shale pile from entering the White River. There is no practical alternative to this dam regardless of the fill plan used, and it must be built before Phase III begins.

The following alternatives to permitting temporary ponding of fresh water at a few locations off tract were examined and rejected because of their lower reliability, need for extensive maintenance, and increased exposure to possible contamination.

- A small-diameter tunnel to divert the drainage south of the processed shale into the natural basin west of the site
- Conduits placed under the processed shale to transmit ponded water to the northern retention reservoir
- Permanent pumping systems to transfer the water to an adjacent natural drainage basin or freshwater basin
- A porous zone of crushed rock placed beneath the processed shale pile to allow percolation of impounded water along the natural drainage

As the revegetation program progresses (described in Section 3.10) in the later years of the program, most rainfall will be retained on the surface where it will either evaporate or be used by the vegetation. The predicted potential for evapotranspiration of 48 inches per year greatly exceeds the annual rainfall, providing an ideal means of water disposal.

As an alternative to retaining surface runoff on the processed shale pile, the surface of the pile could be graded to direct all runoff to the Southam Canyon Reservoir; however, this could create excessive erosion of the shale and inhibit the revegetation program.

7.10.5.4 Dust Control

Dust control measures will include the following:

- Wetting processed shale upon exit from retorts
- Scrubbing vent gas from moisturizers
- Enclosing conveyors
- Wetting shale at loadout bins as it is discharged both from conveyors and onto trucks
- Continuously maintaining truck haul routes by wetting and chemical stabilization techniques
- Wetting shale after spreading and compaction

The only alternative being considered is the possible addition of a chemical wetting agent if necessary. Dust control methods are discussed in detail in Section 4.2.

7.10.5.5 Revegetation

The lease stipulates that all disturbed areas be revegetated as quickly as possible to minimize leachate and stability problems, as well as for aesthetic reasons. An exhaustive discussion of revegetation methods is found in Section 4.6.

7.10.5.6 Evaluation and Selection

The most probable plan is to place processed shale in Southam Canyon, on tract. The chosen fill plan for Phases III and IV begins from the Phase II pile; moves to the south, west, and north; and makes surface early and steadily available for revegetation. The natural drainage pattern of Southam Canyon is not interfered with until the 10th year; contaminate runoff is contained by the Southam Canyon rentention dam. Dust control and revegetation will be expanded versions of methods used in Phase II.

7.10.6 ABANDONMENT

When the commercial oil shale has been mined out and the project is abandoned, several courses of action may be considered.

Processed Shale Disposal. It has been suggested that processed shale be returned to the mine. This has several disadvantages: the problem of storing the shale until parts of the mine are exhausted and ready for refill; and, if the mine is filled, the unavailability of leaner shale and remaining pillars for mining if appropriate technologies are later developed. Because the shale expands in mining and handling, it could not all be returned to the mine. At present, this alternative is not considered feasible.

Shale Pile. The processed shale pile in Southam Canyon should be satisfactorily stabilized against undesirable erosion within 10 years after abandonment, depending upon climatic conditions. Stabilization will be brought about by surface contouring and revegetation. After abandonment, the pile will be monitored to ensure that revegetation is progressing satisfactorily. When stable, no further attention should be required because the evapotranspiration greatly exceeds the annual rainfall. (Although this is true on an annual basis, short-duration high-intensity thunderstorms will result in surface runoff which will be contained by the contoured side slopes of the processed shale pile and retention dam.)

Water Impoundment. There are two possible problem areas: the Southam Canyon retention dam and the off-tract, southern part of Southam Canyon, near the south edge of the processed shale pile.

Additional information must be gathered during the project to determine the following conditions and requirements at the retention dam:

- Characteristics of the impoundment
- Necessity for fencing
- Actual volume of sediment runoff to reevaluate the holding capacity of the reservoir
- Seepage

The retention dam will be designed to contain the 100-year storm. But since the potential evaporation exceeds the surface runoff, there probably will be little or no water standing behind it most of the time.

Some storm runoff water may be trapped behind the shale pile in the southern part of Southam Canyon. The potential evaporation is expected to dispose of this volume of clean water, which, in the interim, could attract wildlife to the area.

7.10.7 RAW SHALE FINES DISPOSITION

In Phase II, the most probable plan disposes of fines, along with the processed shale. These fines will be processed for oil in Phases III and IV when fines-type retorts have been installed. At the present time, the quantity of fines is unknown.

It is recognized that some loss of resource occurs when the fines are so disposed of in Phase II. However, there are significant difficulties attendant to storing the fines until Phase III: the space required by long-range storing, the effects of weather upon the stockpile, control of run-off, and the dust and cost problems occasioned by double handling. The additional amount of oil that might be extracted is felt to be too small to outweigh the problems of storage.

Section 7.11

Section 7.11

SOLID WASTE DISPOSAL

In this section, the alternatives for solid waste disposal are described. These wastes are materials other than shale solids. Where possible, the advantages and disadvantages of each alternative are weighed and compared with the selection criteria, and the most probable case is selected.

Three alternatives of waste disposal were considered. They include:

- Landfill incorporated with processed shale disposal pile (proposed case)
- Landfill independent of processed shale disposal pile
- Combination of incineration and landfill

Many alternatives of solid waste collection and transport are possible. However, the differences with respect to the technical, economic, and environmental selection criteria are considered to be minor, and therefore they are not discussed.

Only a small portion of the solid wastes may be economically salvageable. These solid wastes will be salvaged when practical.

7.11.1 LANDFILL IN PROCESSED SHALE DISPOSAL AREA (PROPOSED)

In this alternative, solid wastes from construction and operation activities would be deposited by landfill methods in the processed shale disposal area. Transport would be by truck, by conveying with the processed shale, or by a combination of these methods. During construction periods, the construction-related wastes would be disposed of

at a landfill site which would later be covered with processed shale. When processed shale is being produced, solid wastes would be layered in the processed shale. Slurry wastes would be mixed uniformly with processed shale. Overall, several small sites, all within the processed shale disposal area, would be involved.

7.11.2 SEPARATE LANDFILL (ALTERNATIVE)

In this alternative, construction and operation wastes would be collected and hauled by truck to a landfill disposal site separate from the processed shale disposal area but still on tract. The site, such as an area about 1-1/2 miles northeast of the plant, would be close to the plant, readily accessible, and away from any major drainage channel. Access road and site would be developed upon initiation of commercial development construction and would be operated throughout the project life. All solid wastes, except shale dust, would be buried in the landfill. Suitable erosion, runoff, leachate, dust, and litter control procedures would be employed to assure acceptable operation of the site. The completed sections of this landfill would be revegetated.

7.11.3 COMBINATION OF INCINERATION AND LANDFILL (ALTERNATIVE)

In this alternative, all combustible solids would be segregated and burned in an onsite incinerator. The remaining waste, along with the incineration ash, would be disposed of in the processed shale disposal area as in the proposed case. The composition and the quantity of combustible waste will vary during the various phases of the project. Generally speaking, however, the combustible solid waste will be a small fraction of the total solid waste generated (less than 20 percent) over the life of the project.

7.11.4 COMPARISON OF ALTERNATIVES

The three alternatives were evaluated according to major technical, environmental, and economic factors, and the results are given in Table 7.11-1. As indicated in this table, the proposed case of disposal in the processed shale pile has the lowest cost and the least impact on the environment, especially because no additional land area will be disturbed.

Table 7.11-1

COMPARISON OF SOLID WASTE
DISPOSAL ALTERNATIVES

Selection Criteria	Landfill with Processed Shale (Proposed)	Separate Landfill (Alternative)	Incineration and Landfill (Alternative)
Technical factors			
• Feasibility	Landfill is well suited to the changing WRSP waste loads and characteristics	Landfill is well suited to the changing WRSP waste loads and characteristics	Potential problem in design and operation of incinerator for changing waste loads and characteristics
Environmental factors			
• Land area disturbed	No additional area[(a)]	70 acres	1 acre (incinerator)
• Air emissions	Small amount of dust from landfill area	Small amount of dust from landfill area	Small amount of dust from landfill area; incinerator flue gas pollutants
• Groundwater and surface water affected	No additional water affected	Potential contamination runoff, leachate control required	No additional water affected
• Revegetation	No additional revegetation needed[(a)]	70-acre disturbed area	No additional revegetation needed[(a)]
Economic factors (relative costs)			
• Access, land and site preparation	Low (cost shared with processed shale disposal)	High (new road and site development required)	Moderate (incinerator site development)
• Equipment and manpower	Low (some shared with processed shale disposal)	Moderate (typical for industrial landfill)	Moderate high (incineration expensive)
• Environmental control and monitoring	Low (minimum additional needed)[(a)]	High (independent erosion, runoff, leachate control, and monitoring needed)	Moderate (flue gas cleanup and emission monitoring needed)

(a) In addition to that planned for processed shale disposal.

Section 7.12

Section 7.12

SUPPORT FACILITIES AND REQUIREMENTS

7.12.1 ELECTRIC POWER SUPPLY

To meet the electric power supply requirements for the full-scale commercial project, three alternatives are considered: constructing an onsite power plant to generate all the required power; purchasing all the required power from an outside source; and purchasing only enough power to avoid burning product shale oil.

7.12.1.1 Self-Sufficient On Tract

A self-sufficient power plant located on the lease tract is the alternative selected for inclusion in the most probable plan for the full-scale commercial project. Such a plant would be independent of an outside source of power but would have the disadvantage of using some of the valuable shale oil product as boiler fuel.

There is some prospect that a new power plant will be constructed near Tracts U-a and U-b. It could become part of a power system capable of supplying electricity to the White River project at lower cost than burning product oil in an onsite power plant.

7.12.1.2 Totally Purchased Electric Power

Under this alternative, the White River Shale Project would purchase all the required electric power except for minor amounts to be supplied by emergency standby equipment. The total capital investment for the plant then would probably be considerably reduced. However, it would

be necessary to incinerate the excess low-Btu gas, thus wasting potential fuel. This loss of fuel for power generation would be reflected in increased plant operating cost through the purchase of outside power.

7.12.1.3 Partially Purchased Electrical Power

Another alternative is to purchase only enough power to avoid burning any of the product shale oil as boiler fuel. The outside power needed in this instance would be about 65 megawatts in addition to about 135 megawatts produced by burning all the excess low-Btu gas for onsite power generation.

7.12.2 BOILER OPERATING PRESSURES

As for the full-scale commercial plant, steam will be generated and used at several levels in the process units in accordance with prevailing conditions and requirements. The steam system in the process units will include headers at 600 psig and 750°F, at 600 psig saturated, at 150 psig saturated, and at 50 psig saturated. Steam generated at the boiler house will be delivered to the main turbines at 1,500 psig and 900°F, conditions more suitable for this service than the lower pressures of the process unit steam mains.

The main turbines will be arranged for steam extraction at 600 psig to provide steam needed for smaller turbine drivers used in process and offsite services, the extraction rate being available to allow an overall steam balance to be maintained.

The boiler design pressure will be 1,800 psig to allow a margin for operating pressure drop and for the increased pressure that will exist during possible relief valve discharge.

7.12.3 AIR COOLING VERSUS WATER COOLING

The full-scale plant has been arranged to make use of air-cooled coolers and condensers, including the power plant steam condensers. This has been done to reduce the requirement for plant makeup water.

Since adequate water is available, a worthwhile savings in energy investment and also in operating cost might be realized by using water-cooled exchangers as an alternative. This alternative will be thoroughly investigated before initiating the final engineering design for the commercial plant.

7.12.4 ALTERNATIVES EVALUATION

The choices offered for the full-scale commercial plant, and the various alternatives mentioned in this report, have been made on the basis of overall economics and practicality. Of necessity, judgmental factors have exerted a strong influence. Later, during the detailed engineering design of the plant, these alternatives will be reexamined.

7.12.5 SELECTION RATIONALE

The alternatives considered for utilities and offsites are evaluated primarily for technical and economic feasibility. Other factors may indicate a need to make forecasts of future events.

For instance, there is little prospect that self-sufficiency in electric power (based on burning low-Btu gas fuel plus some of the refined shale oil product) can be competitive with the purchase of outside electric power. It is assumed that the projected new power plant is actually built in time to be available for this project.

If outside electric power is finally available at a low cost, there could be an economically feasible alternative based on buying substantially all of the needed electric power, and incinerating a considerable volume of excess low-Btu gas. This alternative probably could not be given serious consideration because of the attendant energy waste and the adverse environmental effects from the additional stack gas.

A combined cycle power plant might be devised to reduce the use of refined shale oil product as plant fuel. At present, such a design would seem to require the development of gas turbines capable of firing low-Btu gas or fuel mixtures containing some percentage of this gas. In the detail design of the plant, such possible improvements in efficiency will be given careful attention.

Section 7.13

Section 7.13

ANCILLARY FACILITIES AND MAINTENANCE

7.13.1 PLANT DRAINAGE

The intent of the drainage plan that is incorporated into the facilities described in this Detailed Development Plan (DDP) is to maximize the use of natural drainage courses for stream runoff while ensuring the retention of contaminants and prevention of erosion as a result of project activities.

Erosion, drainage, and contaminant control are accomplished with ditches, surface grading, revegetation, stabilizing techniques, and dam impoundments. Three dams will prevent contaminated drainage flows from reaching the White River. These are:

- Phase II catchment dam
- Southam Canyon retention dam, Phases III and IV
- Wastewater and storm runoff holding basin

The facilities considered in this section relate to the third category above; the others are discussed elsewhere in appropriate sections of this DDP.

These facilities are similar to those used in essentially all major industrial plants handling chemicals and hydrocarbons. Since the alternative procedures and equipment for dealing with these matters have been investigated, evaluated, and standardized to a significant degree, the range of alternatives considered have been restricted essentially to modest variations only.

7.13.1.1 Oily Water Sewer System

An oily water sewer system should:

- Achieve economical collection of all waste waters contaminated by oils
- Provide a means of removing flammable liquid spills quickly from operating and hazardous areas
- Provide a means of controlling fire spread in an area by limiting surface propagation of fires from liquid carryover from one area to another

7.13.1.2 Storm Sewers

Storm sewers should:

- Economically collect and convey surface runoff uncontaiminated by hydrocarbons and other pollutants
- Intercept and collect uncontaminated runoff to minimize flows of waste streams through treatment facilities
- Minimize chances of collecting accidentally contaminated waters, which would necessitate treatment not normally given to these flows

7.13.1.3 Sanitary Sewers

The system of sanitary sewers should:

- Provide an efficient means for the collection of all sanitary wastes for conveyance to the treatment plant
- Minimize flows through the treatment system by eliminating sources of flows not requiring treatment as sanitary wastes

7.13.2 PLANT DRAINAGE SYSTEMS

The drainage systems for the main plant area consist of separate oily water sewers, storm sewers, and sanitary sewers. All three sewers

are segregated, and their flows are treated separately. The oily waste stream and sanitary sewage are treated in the same waste treatment plant but by different procedures. The storm runoff collected by the storm drain system is routed to the holding basin. There, the oily waste accidentally picked up in the stream is separated and recovered before the runoff is used as low-TDS makeup water.

7.13.2.1 Oily Water Sewers

The selected alternative consists of an oily water sewer system draining operating process areas subject to oil contamination. To permit wash-down of oily wastes into the system, the surfaces in the area are paved and impervious. All storm runoff and fire-fighting water in these areas is collected in this system. All lines are liquid-sealed against propagation of flammable vapors from one operating area to another. Surfaces are sloped to prevent hydrocarbon liquid flowing from one operating area to another. All manholes in hazardous areas have vapor-tight lids with vents discharging in safe areas.

7.13.2.2 Storm Sewers

The selected system collects all runoff from areas not normally subject to hydrocarbon contamination. The runoff from these areas is collected primarily by a ditch and culvert system. Storm runoff in the diked tankage area is stored behind the dikes for the duration of a storm. The water is drained to the storm sewer system after large storms, but it is left to evaporate behind the dikes after minor storms. The storm sewer system channels all of the foregoing runoff into the holding basin, which is located to collect all runoff not otherwise intercepted in the drainage basin containing all plant facilities.

7.13.2.3 Sanitary Sewers

The system collects only sanitary sewage from all sources within the plant drainage basin, and routes this sewage to the waste treatment plant. Only minor pretreatment, such as grease separation at the cafeteria, is provided prior to treating in the waste treatment plant. Provisions may include a floating solids separation unit (septic tank) at all facilities generating sanitary wastes. The effluent would be chlorinated and discharged into the oily water sewer system, which would then be a combined system conveying flow to the waste treatment plant. This system requires that the combined flow be treated for oil separation and removal as well as for sanitary sewage stabilization.

Section 7.14

Section 7.14

WATER SUPPLY FACILITIES

In making the assumptions and stating the premises that were used in the initial feasibility study for the project, the White River Shale Project adopted the principal of a facility design based on minimum water use. This decision was taken because no water source had been identified and because of the obviously high relative value of water in southern Uintah County.

Tables 3.14-2 and 7.14-1 show the practical minimum requirements for water, and Figure 3.15-3 the water balance. These requirements have been retained in the DDP most probable case because they result from detailed calculations and illustrate the principles of water conservation that will be employed in the final design.

There are, however, many variables that can affect water consumption, and most of these will increase the total water requirement. For example:

- There is a wide variation in water required for cooling, dust suppression, and compaction of the processed shale resulting from the various retorting systems. The actual water use for these purposes will depend on the final selected retorting system and operating experience.
- Regardless of the selected retorting system, the water requirements shown for an acceptable degree of dust control and shale compaction are only estimates and could well be higher.

- There is a substantial tradeoff between water use and energy production in the design of the cooling systems for the plant, as discussed in Subsection 7.12.3, and shown in Tables 3.14-2 and 7.14-1.

To set the range of the water requirements for the commercial facility located on U-a and U-b, the White River Shale Project has established 13,000 acre-feet per year as the practical minimum requirement and 26,000 acre-feet per year as the practical maximum. The amount actually used will probably fall between these extremes.

Table 7.14-1

COMMERCIAL PRODUCTION PHASE WATER REQUIREMENTS

Item	Water Requirement	
	Average (gpm)	Annual Average (acre-feet)
Practical minimum requirement		
Process plant	5,960	9,700
Processed shale dust control and irrigation, and other undefined uses	1,000	1,600
Minor losses including seepage and evaporation	1,040	1,700
Total minimum requirement	8,000	13,000
Practical maximum requirement		
Minimum requirement		13,000
Add: raw water for 100% water cooling the process and utility plants		8,750
Add: contingency, 20%		4,250
Total maximum requirement		26,000

7.14.1 WATER SUPPLY DEVELOPMENT PROGRAM

Providing water for the development of oil shale in eastern Utah, as well as serving other essential uses and purposes, is a matter of obvious importance. This subject has been studied and reported on by Bingham Engineering of Bountiful, Utah (Ref. 37). This subsection (7.14.1) has been abstracted from the above reference.

7.14.1.1 White River Dam

The preferred alternative is a 125-foot-high dam and reservoir on the White River, with related pumping facilities for delivery of water to the oil shale lease Tracts U-a and U-b. The project would be a multipurpose development that would provide a firm water supply for oil shale processing on lease Tracts U-a and U-b with a capacity sufficient to furnish water for additional oil shale development in the area.

Several alternatives for providing water for development of oil shale near the White River in eastern Utah have been studies (Ref. 72), in addition to the White River Dam. Two of these plans are examined in detail, with a multipurpose reservoir on the White River being the preferred method of providing water for oil shale development.*

7.14.1.2 Flaming Gorge Plan

Water would be released from Flaming Gorge Reservoir into the Green River and would be pumped from the Green River at a point about 23 miles northwest of Bonanza. About 27 miles of 39-inch and 27-inch pipeline would be required to deliver water to the lease tracts, with pumping facilities required to lift water about 1,200 feet.

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*Unless otherwise noted, the alternatives outlined contemplate delivery of 26,000 acre-feet of water per year to the lease tracts.

7.14.1.3 Starvation Reservoir Plan

Water would be released from Starvation Reservoir on an interim basis until required by the Central Utah Project. The water would be allowed to flow down the Duchesne River to serve as replacement water for that pumped from the Green River just above the Duchesne River confluence.

7.14.1.4 Tyzack Reservoir Plan

This plan calls for completion of the Tyzack Reservoir on Big Brush Creek as part of the Jensen Unit of the Central Utah Project. The project would make available only 8,000 acre-feet of water per year, but it could be high-quality potable water if delivered directly from the reservoir.

7.14.1.5 Watson Reservoir Plan

This plan calls for construction of a major water storage facility on the White River, with the 140-foot-high dam located about 2-1/2 miles upstream from the old Ignatio Stage Stop. The dam would create a reservoir of about 102,000 acre-feet that would back water into Colorado. Water would be released from the reservoir into the White River, and from there it would be pumped to meet the oil shale requirement.

7.14.1.6 Hells Hole Canyon Reservoir Plan

Under this plan, a 25,000 acre-foot offstream reservoir would be constructed in Hells Hole Canyon, a small tributary to the White River near the Watson Dam. Water would be pumped from the White River into the reservoir created by a 294-foot-high dam. It would then be pumped from the reservoir to meet the oil shale requirement. The offstream site has the advantage of alleviating the sediment problem inherent in a main stream reservoir.

7.14.1.7 Other Alternatives

Additional water sources have been examined on a reconnaissance level to satisfy the potential requirements for oil shale development.

- The first of these is to pipe water from Starvation Reservoir to the oil shale tracts. While no economic comparisons are available for this alternative, its cost appears to be excessive simply because of the long pipeline required (about 62 miles).
- The second alternative would require construction of several small reservoirs on the upper tributaries of Willow Creek some 30 to 35 miles southwest of the oil shale lease tracts. Delivery of this water to the White River Shale Project would require an extensive network of tunnels, canals, and pipelines, and the cost appears to be prohibitive at this time.
- Groundwater supplies are available, but not in quantities large enough to serve the oil shale project.

7.14.2 ALTERNATIVE SOURCE EVALUATION

From the aforementioned alternative sources of water, two were selected for more detailed study. Both of these alternatives are shown in Figure 7.14-1. The preferred alternative is the White River Dam, as indicated in Subsection 3.14.1.1.

The second alternative is a single-purpose pipeline with the appurtenant pumping facilities to deliver from the Green River water that has been released from storage in Flaming Gorge Reservoir. This alternative would have a minimal environmental impact: water would be supplied through an existing storage facility; water flows in the Green River would not be significantly altered; the pumping facilities would require a relatively small amount of land; and the pipeline would be buried and largely hidden from view. The principal adverse impacts appear to be the greater amount of energy required to operate the pumping facilities, the single-purpose nature of the pipeline, and the higher cost of the pipeline.

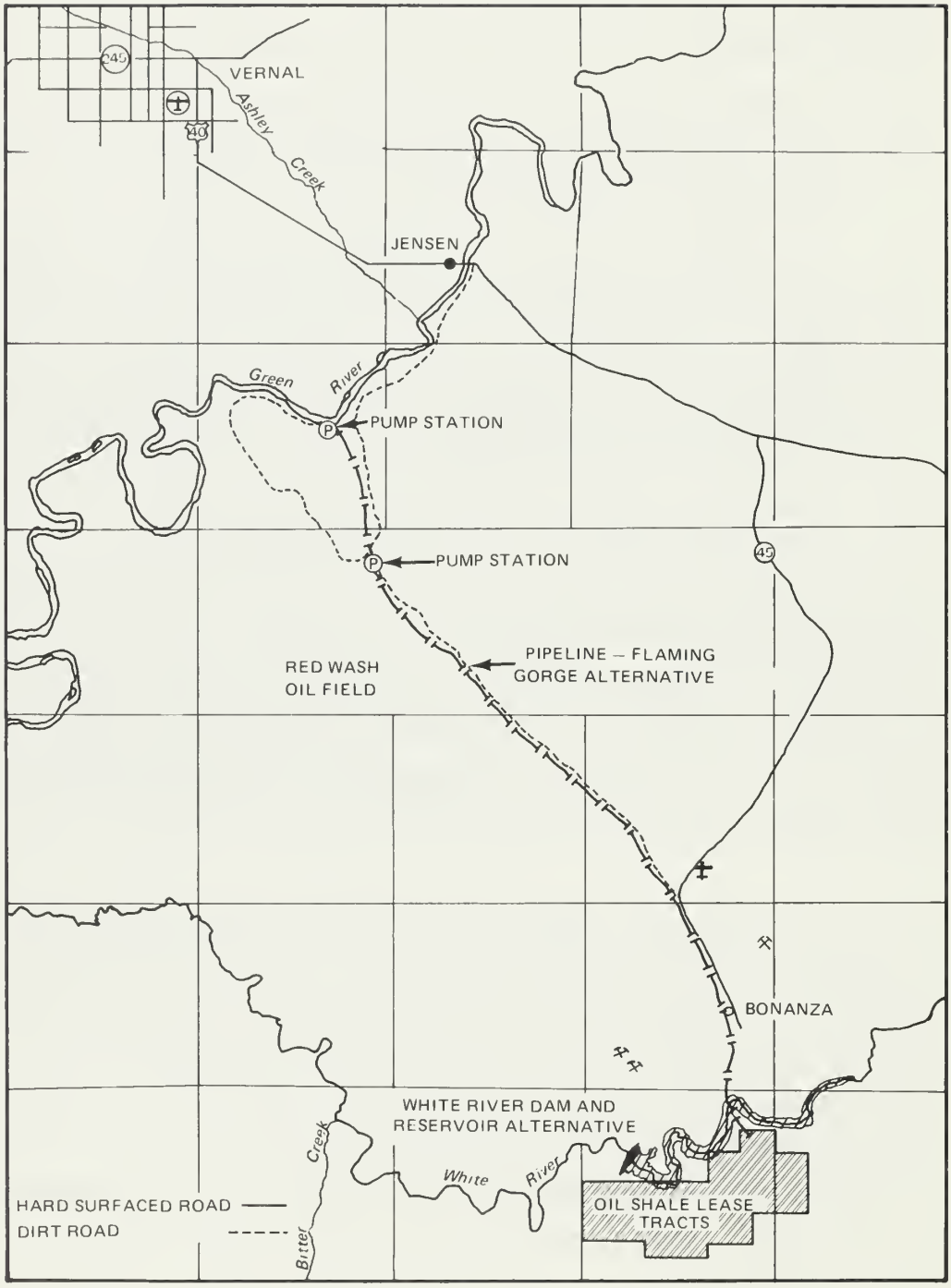

Figure 7.14-1. Alternative Water Sources

7.14.3 WATER RIGHTS

The U.S. Bureau of Reclamation has available approximately 500,000 acre-feet of water annually in storage in Flaming Gorge Reservoir. The Bureau has indicated a willingness to release water down the Green River so that it could be picked up and pumped to oil shale lease Tracts U-a and U-b and used for oil shale processing. Discussions held with Bureau of Reclamation personnel indicate that this raw water could be purchased and delivered to the Green River pump station for $10 per acre-foot. The Bureau suggested that the material contained in one of its 1974 publications (Ref. 72) can be construed as its commitment to supply water from Flaming Gorge Reservoir.

As discussed in Subsection 3.14.1.4, it appears reasonable that the quantity of water required could be made available to the White River Shale Project.

7.14.4 RAW WATER DELIVERY SYSTEM

7.14.4.1 White River Dam

The water supply facilities for the commercial operation phases of the White River Shale Project would consist of:

- A pumping station located on the south bank of the reservoir on the White River
- A 2.0-mile pipeline from the pumping station
- An on-tract storage pond at the terminal end of the pipeline
- A 0.4-mile pipeline to the plant area
- A 2.0-mile pipeline to the processed shale disposal area

The range of water requirements were determined to be approximately as shown in Table 7.14-1.

Raw water for the plant and processed shale uses will be pumped from the White River Reservoir through a 24-inch-diameter pipeline. The pumping station at the reservoir will be a fully enclosed structure housing screened intakes, pumps, motors, electrical switchgear, and mechanical systems. The pumps will be capable of pumping the average water requirement, with allowance in capacity for peak demands. Supervisory and telemetering equipment will be included to provide full remote control from the process plant control room. The power supply for the pumping station will be provided from the White River Shale Project power plant.

The on-tract storage pond will be constructed to provide operational flexibility and 3 days' reserve storage of 210 acre-feet to maintain a reliable supply of water during an outage of the reservoir pumping station or pipeline. Although no subsurface exploration or material testing has been performed, it is projected that the pond will be formed by an earthfill dam. In the construction of this dam, maximum use will be made of local materials.

An outlet system will distribute water from the pond to the plant and to the processed shale disposal area. This system will permit the flow to be synchronized for delivery to the plant, the processed shale area, or both. The average plant demand and the processed shale control requirement will be delivered by gravity from the storage pond through separate pipelines.

All pipelines will be buried below the frost depth for freeze protection and will be protected against corrosion, as required.

7.14.4.2 Flaming Gorge Reservoir

The alternative water source for the White River Shale Project is the Green River. The water supply facilities would consist of the following:

- A pumping station located on the south bank of the Green River, approximately 14 miles southeast Vernal and 6 miles east of Horseshoe Bend
- A 33.0-mile pipeline from the pumping station to the on-tract storage pond
- The distribution system from the storage pond, and other features similar to those described in Subsection 3.14.2

The average water requirement would be pumped in a single lift, or in multiple lifts if studies show it to be economically more feasible, through a steel pipeline of about 30 inches installed within the utility corridors following State Routes 264 and 45 to the southeast. The pipeline would cross the White River at the Highway Bridge near the Ignatio Stage Stop and would discharge into the on-tract storage pond. The pumping station would consist of a fully enclosed structure housing traveling screens, vertical turbine pumps, motors, electrical switch-gear, and mechanical systems. Supervisory and telemetering equipment would also be included to provide full remote control from the process plant control room. The power supply for the pumping plant would be provided from the existing 69-kilovolt transmission line.

The storage pond and the distribution system to the plant and the processed shale area would be as described for the water supply facilities developed for the White River source, during both construction and operation phases.

7.14.5 WATER TREATMENT

The U.S. Geological Survey record (Ref. 73) indicates that the water quality of the Green River is similar to that of the White River. The two rivers have approximately the same turbidity, total dissolved solids, alkalinity, silica, and hardness contents, and will require the same level of treatment for the White River Shale Project use.

Several equipment suppliers can be used, but the concept of the overall treatment system (Section 3.14) will be the same regardless of the equipment, and the difference in the cost, if any, between alternative suppliers will be insignificant.

Selection of the raw water source between the White River and the Green River will be based on availability, the cost, and the environmental impact of the supply system, and not on the treatment requirement.

7.14.6 SELECTION RATIONALE

The comparison of the two alternatives selected for close consideration is a difficult one because one of the two proposals (White River Dam) serves more than the single purpose of supplying water to the White River Shale Project, and is involved in discussions being carried on in the State of Utah by parties directly interested in and affected by the potential White River Dam. The preference for the White River Dam, as expressed in this most probable plan for the White River Shale Project, is based on its close proximity to the leases, the multiple benefits served by the dam, the competence of the dam site, the efficiency of the reservoir, and its lower cost.

Section 7.15

Section 7.15

WASTEWATER MANAGEMENT PLAN ALTERNATIVES

Selection of the most probable wastewater management plan is governed by the following objectives:

- Eliminating wastewater discharges to receiving streams
- Reusing the wastewater whenever practicable
- Conforming to all applicable rules and regulations
- Preventing hazards to public health and safety
- Minimizing adverse environmental impacts
- Selecting most economical treatment systems

In addition, the selection depends on the quality and quantity of wastewater, on the water reuse potential, and on discharge limitations.

Wastewater management plan alternatives are presented in this section, along with the selection rationale behind the proposed action. The sources, expected flow rates, and characteristics of wastewaters are presented in Section 3.15.

7.15.1 COLLECTION ALTERNATIVES

The wastewater collection alternatives are based on the level of stream segregation. There are three major alternatives:

- Alternative A — No Segregation. All wastewater streams would be collected and discharged into the treatment facilities through one sewer network.

- Alternative B – Minor Segregation. Streams would be segregated to a lesser degree than those in Alternative C, but through more than a single sewer.
- Alternative C – Major Segregation. Streams that are compatible in quality and in flow pattern would be collected through the same network and discharged separately into the treatment facilities.

To achieve the wastewater management plan objectives, wastewaters should be collected in such a way as to permit the optimization of their treatment and reuse. This would require major stream segregation according to type and level of contamination. Accordingly, Alternative C is selected, resulting in four sewer collection systems.

The sewers and collected major streams are:

- High-TDS Sewer. High TDS – blowdowns from stream generators, boilers, cooling tower

  Sour Water – from sour water stripper
- Oily Sewer. Washdown streams – from main process plant area
- Sanitary Sewer. Sanitary waste from employee facilities
- Storm Sewer. Contaminated runoff from contaminated and potentially contaminated areas

7.15.2 TREATMENT ALTERNATIVES

The degree to which wastewater streams need to be segregated depends primarily on the required treatment, which in turn depends on the intended reuse. The plans are to reuse all the wastewater streams as makeup to the scrubber for the secondary crushers. (Alternative water reuse schemes are discussed in Subsection 7.15.3.)

The treatment alternatives discussed below for each of the wastewater streams were evaluated for the possibility of reusing all the wastewater and eliminating any discharge to natural water bodies.

7.15.2.1 High-TDS Wastewater

Treatment of this stream emphasizes inorganic salts removal. The alternatives include:

- Alternative A – No Treatment. The stream would be reused directly as makeup to the secondary crusher scrubbers without receiving any treatment.
- Alternative B – Inorganics Removal. The salts would be concentrated by a membrane process (reverse osmosis, electrodialysis) or through one of several processes. The two "products" of such processes are brine and low-TDS water. The brine would be used as makeup to the secondary crusher scrubbers and the low-TDS stream would be used as process water.

Presently, the estimated makeup needs of the secondary crusher scrubbers exceed the total projected wastewater flows. Since the scrubber water need not be desalted, inorganic removal is not necessary. Accordingly, Alternative A is selected.

7.15.2.2 Stripped Sour Water

Alternatives for treatment of the sour water include:

- Alternative A – No Treatment. The stream would not be treated.
- Alternative B – Steam Stripping. The stream would be steam stripped only.
- Alternative C – Additional Treatment. The stream would be stripped and then, along with the plant washdown stream, subjected to flotation and biological oxidation.

Since the stripped sour water quality satisfies the reuse application, and since health hazards and nuisance are minimized through segregation and later dilution of the stream, Alternative B is selected.

7.15.2.3 Plant Washdown

The treatment alternatives are:

- Alternative A – Conventional Treatment. The stream would be subjected to surge attenuation, followed by gravity separation of suspended solids.
- Alternative B – Additional Treatment. The stream would be treated as in Alternative A and then, along with the stripped sour water stream, subjected to flotation and biological oxidation.

As indicated previously, the reuse application does not warrant any treatment beyond surge attenuation and gross suspended solids and oil removal. Accordingly, Alternative A is selected.

7.15.2.4 Sanitary Wastewater

Possible alternatives for the sanitary wastewater treatment include:

- Alternative A – Minimum Treatment. The stream would be chlorinated only.
- Alternative B – Conventional Treatment. The stream would be chlorinated after treatment through a sedimentation plus a biological oxidation process.
- Alternative C – Advanced Treatment. The stream would be treated as in Alternative B, with the addition of a residual organics removal process (e.g., carbon adsorption).

Alternative A is not acceptable because biological treatment is necessary to prevent health hazards and nuisances (e.g., odor, coloration, algal stimulation). Alternative C is not warranted in view of the planned reuse. Consequently, Alternative B is selected.

7.15.2.5 Contaminated Runoff

The contaminated runoff alternatives are:

- Alternative A — No Treatment. The stream would be reused without treatment.
- Alternative B — Solids Removal. The stream would be reused after treatment to remove floatable and settleable solids.

To minimize nuisance, hazards to humans and wildlife, and sediment loading of the ponds, Alternative B is selected.

7.15.3 REUSE ALTERNATIVES

One of the primary objectives of the wastewater management plan is to have zero discharge. This can be achieved through the reuse of all the wastewater generated. Two main alternative reuse schemes were considered:

- Alternative A — Scrubber Makeup. The wastewater would be used totally for makeup to the secondary crusher scrubbers, and then for wetting the processed shale.
- Alternative B — Scrubber and Cooling Tower Makeup. Part of the wastewater (high TDS) would be used as makeup to the scrubbers, and the remaining part (low TDS) would be used as cooling tower makeup.

Alternative A is selected because the use of wastewater as cooling tower makeup would necessitate, at the very least, biological oxidation treatment, (whereas its use as scrubber makeup does not), and because the scrubber demands exceed the total wastewater flow.

However, this scheme assumes mine water production is insignificant. If mine water (which is expected to contain a high-concentration of inorganic salts) is encountered, the following alternatives would be considered, and the one that best satisfies the no-discharge objective would be selected.

- Alternative A – Moderate Mine Water Production. If there is a moderate production of mine water, the mine water, along with the high-TDS streams, would be used for dust control inside the mine and as the scrubber makeup. The low-TDS streams would then be treated further in a biological oxidation system and then filtered before reuse as part of the cooling tower makeup.
- Alternative B – High Mine Water Production. For high mine water production, if the mine water production rate exceeds the sum of the requirements for dust control, processed shale wetting, and scrubber demand, then a portion of the water would have to be desalted. The desalted stream would be used as part of the plant fresh water supply (process use only). The fresh water intake and net wastewater production rates would be reduced accordingly.

A graphic presentation of the proposed plan and these two alternatives is shown in Figure 7.15-1.

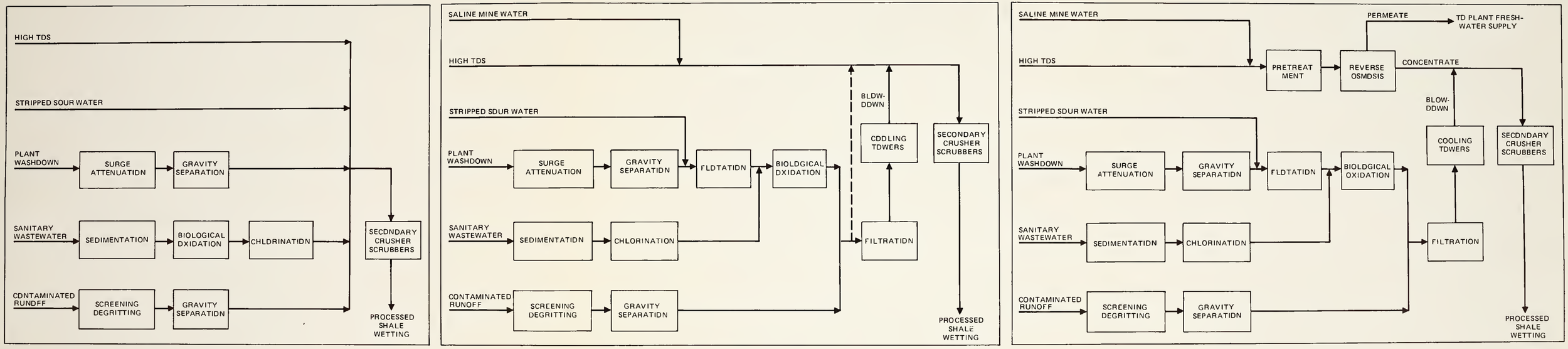

Figure 7.15-1. Wastewater Reuse Alternatives

Section 7.16

Section 7.16

CORRIDOR PLANNING

During project development, several offsite corridors will be required to provide transportation and utility services to or from the project site. These include a corridor for an access road, a power line, a water supply pipeline (an alternative if the White River Dam is not constructed), and an oil pipeline to transport the product. Pipeline corridor alternatives are discussed in Section 7.17, "Product Transport."

At this stage of development, the locations of most of the alternative corridors have been identified only in general terms. Under the present schedule, construction of some of the facilities will not begin for 7 or 8 years. During engineering design, exact routes will be surveyed and specific information will be available for evaluating more fully the environmental impact of the corridors.

Many of these facilities can be located along corridors of the same facilities. By exercising care and judgment in selecting and developing joint corridors wherever possible, the White River Shale Project will be able to minimize the offsite environmental impact of the project and achieve important economic savings.

7.16.1 SELECTION CRITERIA

The primary criteria considered in evaluating the alternative corridors are as follows:

- Technical considerations
  - Special engineering requirements
  - Timing
  - Capital costs
- Environmental considerations
  - Existing habitat or vegetations
  - Rare and endangered species
  - Historic or archaeological sites
  - Scenic sites or recreation areas
- Socioeconomic considerations
  - Population growth patterns in the region
  - Commuting, time, distance, and general convenience
- Use of existing or joint corridors to minimize the economic and environmental impact

7.16.2 ACCESS HIGHWAYS

Two access highways are discussed in this section: The major highway corridor from Bonanza, Utah, to the project site, and the corridor from Bonanza to Vernal.

7.16.2.1 The Highway Corridor from the Project Site to Bonanza

Three alternative highway corridors from the project site to Bonanza have been proposed. These alternatives are described below.

- Alternative 1. This proposed route would follow a new corridor running southwest from Bonanza and would cross the White River on the crest of the proposed new dam. It would then swing east to connect with the plant site. This corridor would require the construction of a new highway approximately 11 miles long.
- Alternative 2. This alternative would use the existing Highway 45 corridor south from Bonanza. Initial improvements proposed for this route would include resurfacing the first 2 miles south of Bonanza, improving the alignment from that point to the White

River, using the existing bridge over the river, and upgrading approximately 5 miles of the road south of the river. Eventually a new bridge would probably be needed across the White River as traffic increased or if a dam that would inundate the present bridge were constructed downstream. This route would be approximately 9 miles long.

- Alternative 3. This alternative would use the existing Highway 45 route for the first 2 miles south of Bonanza and would then swing east, crossing the White River on a new bridge east of the existing bridge and landing on the west bank of Evacuation Creek. It would then swing west to connect with the plant site. This route would be approximately 10 miles long, and a new highway would have to be constructed along most of this corridor.

Technical Considerations. Timing is an important consideration in highway corridor selection. Alternative 2 would be the only one that could be completed in time to serve the needs of the project in the next few years. Alternative 1 would be dependent on the construction of a new dam across the White River. Alternative 3 would require a new bridge across the White River, and this would take 2 to 3 years to plan, design, and construct.

Environmental Considerations. It appears that Alternative 2 would have the smallest environmental impact for the following reasons:

- The corridor would be shorter.
- Since it would make use of the existing highway, Alternative 2 would minimize new cuts and surface damage, including attendant erosion.
- Most of the biologically important habitat in the area would be located along the river, and any new crossing of the river could reduce the area available for this habitat.

- Field personnel have not investigated Alternatives 1 and 3 in detail, nor have the alignments been specifically identified. However, it is reasonable to assume that development along the existing highway (Alternative 2) would have less impact on rare and endangered species, historic or archaeological sites, and recreation or scenic areas than would the development of new highways (Alternatives 1 and 3).

Socioeconomic Considerations. It is expected that virtually all highway travel to and from the project site would use the selected corridor. Since Alternative 2 would be slightly shorter than either Alternatives 1 or 3, the selection of Alternative 2 would result in discernible savings in driving time and a lower consumption of resources by vehicles traveling to and from the project site.

Use of Existing or Joint Corridors. Only Alternative 2 would be located completely within an existing corridor.

7.16.2.2 The Highway Corridor from Bonanza to Vernal

Three alternative corridors to provide improved highway access between Bonanza and Vernal have been proposed and are shown in Figure 7.16-1. These alternatives are:

- Alternative 1. This corridor would follow a more direct route between Vernal and Bonanza than does the existing unimproved road and power line. The proposed route would require a new bridge over the Green River southwest of Jensen, would be approximately 37 miles long, and would be the shortest of the proposed alternatives.
- Alternative 2. This route would follow existing U.S. Highway 40 to the Jensen Crossing of the Green River; it would then proceed along the southern bank of the Green River, using the existing SR-264 corridor until it intersects with proposed Alternative 1; and then it would follow Alternative 1 on to Bonanza. This route would be approximately 42 miles long.

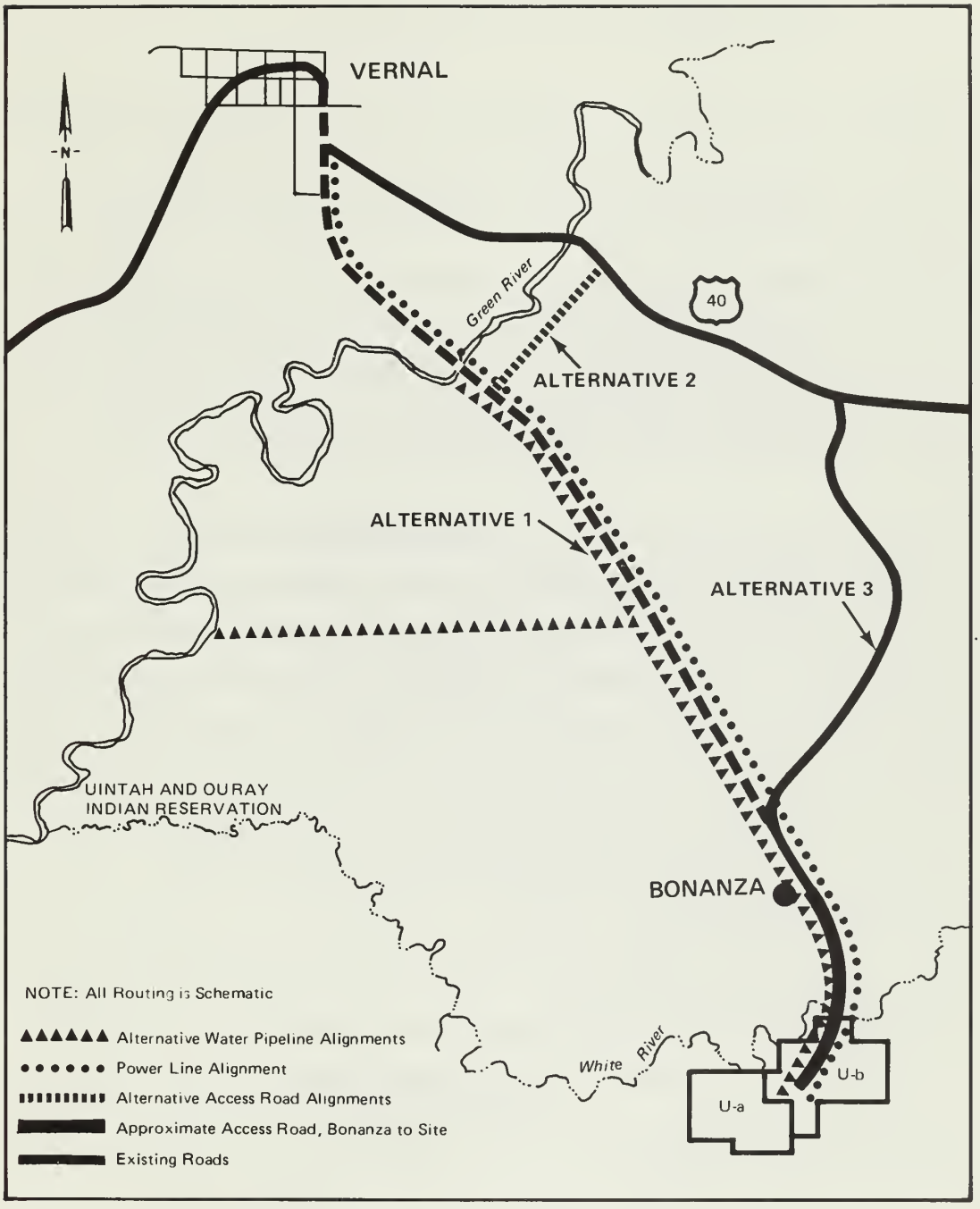

Figure 7.16-1. Corridors from Bonanza to Vernal

- Alternative 3. This corridor would use existing U.S. Highway 40 and Utah State Highway 45, including the necessary upgrading and improvements. The route would be approximately 46 miles long.

Technical Considerations. Alternative 3 could be developed faster than the other alternatives since only improvements and upgrading of the exsiting highway would be needed. With proper planning, this route could provide continued transportation access during this improvement and upgrading period. Since Alternatives 1 and 2 would be primarily new roads along existing corridors, they could not provide transportation access until construction was completed along their entire length. The new bridge across the Green River required for Alternative 1 would take at least 2 to 3 years to plan, design, and construct.

Environmental Considerations. The development of Alternatives 1 and 2 would require more new cutting and filling, with attendant potential increases in erosion and surface damage, than would be required for Alternative 3. Detailed field investigations of the proposed alternative corridors have not as yet been made. However, it is believed that the possibility for undesirable impacts on the existing habitat and vegetation, rare and endangered species, historical or archaeological sites, and scenic or recreation areas would be greater for Alternatives 1 and 2 than for Alternative 3.

Socioeconomic Considerations. Since a large portion of the highway traffic will be between Bonanza and Vernal, Alternative 1 would provide the greatest savings in driving time and resources consumed by vehicles traveling this route. Alternative 3 would be the least desirable from this point of view.

Use of Existing or Joint Corridors. All three alternatives would make use of existing corridors.

7.16.3 POWER LINES

Initially, electric power for the project site will be provided by a new 69-kilovolt transmission line from Bonanza. Moon Lake Electric Association, Inc., will supply this power and will construct the new lines. The alternative corridors are described below.

- Alternative 1. The power line would follow the highway between Bonanza and the project site along the entire route.
- Alternative 2. The power line would follow an existing 12 kilovolt power line southeast from Bonanza along the approximate route of the abandoned slurry pipeline. After crossing the White River, the line would run southwest for about 1 mile to the main access highway and would follow this highway to the process facilities.

7.16.3.1 Technical Considerations

Since Alternative 1 would be along the major access highway, the line would be easier to construct, maintain, and patrol. Alternative 2 would require a longer line, and the existing pole structures would have to be replaced since they were not designed to accommodate a higher voltage line.

7.16.3.2 Use of Existing or Joint Corridors

Both alternatives would make use of existing or joint corridors along most of the route and thus would minimize the impact of the power corridor.

7.16.3.3 Environmental Considerations

Locating the power line along existing or joint corridors should minimize the environmental impact on existing habitat, vegetation, and historic or archeological sites. The power line adjacent to the highway could obstruct scenic views along the route, particularly in the vicinity of the White River.

To provide adequate service from Bonanza to the project site, the power service into Bonanza would have to be improved. Since this could be done by stringing new wire on the structures of an existing line from the Vernal area to Bonanza, a new power corridor between these two points would not be needed. Using this existing line would help reduce economic costs and minimize the environmental impacts.

7.16.4 WATER SUPPLY LINES

An alternative to supplying water for the project from the White River would be to bring it from the Green River. Two alternative corridors have been proposed for this line. These alternatives are shown in Figure 7.16-1 and described below.

- Alternative 1. This pipeline would take water from the Green River at a point southeast of Vernal and would follow an existing corridor in a southeastern direction to Bonanza. There is an existing unimproved road and power line along this corridor. From Bonanza, the pipeline would follow the existing road to the project site, crossing the White River at the existing highway bridge.
- Alternative 2. This pipeline would take water from the Green River at a point approximately 12 air miles southwest of the starting location for Alternative 1. This route would run easterly from the Green River and intersect Alternative 1 near its midpoint. The pipeline route would then be the same as Alternative 1.

7.16.4.1 Technical Considerations

Since Alternative 2 would be approximately 1-1/2 miles longer than Alternative 1 and would take water from the river at a lower elevation, its capital and annual pumping costs would probably be slightly higher. Furthermore, since part of the Alternative 2 would be located on the Uintah and Ouray Indian Reservation lands, approval would have to be secured from two agencies rather than from just the Bureau of Land Management, as in the case of Alternative 1. Construction time should be similar if the necessary approvals are secured.

7.16.4.2 Use of Existing or Joint Corridors

Both routes would use existing corridors.

7.16.4.3 Environmental Considerations

Although specific environmental survey in the field of these alternative routes has not been made, the environmental tradeoffs are thought to be small since both routes would traverse similar terrain. The use of existing corridors that include unimproved roads would serve to minimize environmental damage during construction. With proper rehabilitation techniques, environmental impacts could be practically eliminated in a pipeline corridor. However, in the semiarid conditions found along both corridors, the return of the vegetation to its natural state would take some time.

Section 7.17

Section 7.17

PRODUCT TRANSPORT

Several alternative methods for transporting the shale oil products to markets were investigated, and a pipeline, rather than unit trains, was found to be the most practical method. A 16-inch pipeline will be required to transport the shale oil, and this line should be ready for service for Phase III. During Phase II, the limited amount of shale oil produced will probably be transported to markets by tanker trucks.

The proposed pipeline will convey the shale oil to one of two alternative sites in Wyoming. Both of these sites are intersected by two major pipelines which terminate in the Midwest. Both have excess line capacity and could handle the approximately 100,000 barrels per day of shale oil from the WRSP facility. However, additional pumping capacity would have to be added.

7.17.1 PRODUCT PIPELINE ROUTES

Two major alternative routes were considered for transporting crude oil from the project site to the major existing pipelines in Wyoming, and on to potentially available markets and further refining capabilities. The two pertinent alternatives under serious consideration are offered below and shown in Figure 7.17-1.

- Alternative 1. This route would run from the project site to Casper, Wyoming. From the project site to Colorado Highway 64, the line would follow existing Bureau of Land Management corridors containing pipelines and roads. From Highway 64, the new

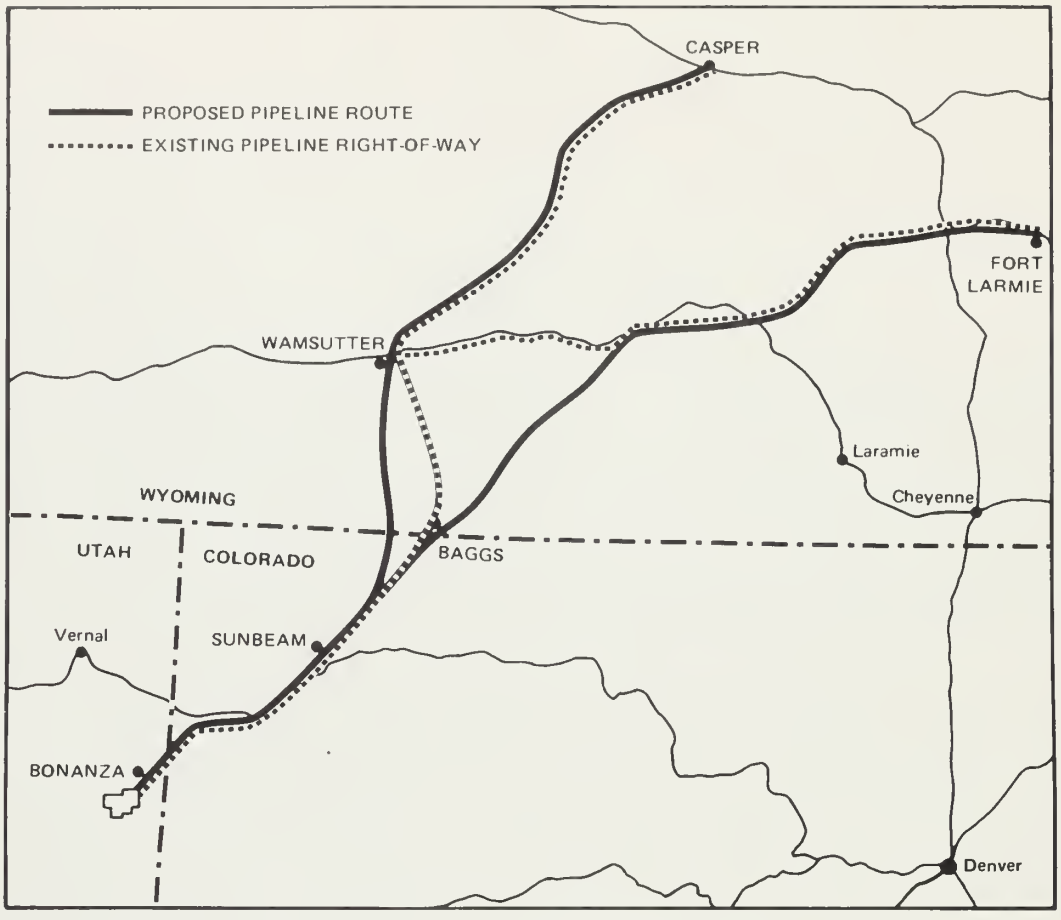

Figure 7.17-1. Product Pipelines – Alternative Routes

pipeline would follow an Amoco right-of-way containing a small-diameter crude line to Sunbeam, Colorado. From Sunbeam, the line would proceed north to Wamsutter, Wyoming. The line from Wamsutter would follow an Amoco right-of-way containing a small-diameter crude line to Ferris, Wyoming.

- Alternative 2. This route would run from the project site to Fort Laramie, Wyoming. From the project site to Highway 64, the route would be similar to that of Alternative 1. The line would follow the Amoco right-of-way from Highway 64 to Baggs, Wyoming, via Sunbeam, Colorado. It would then proceed from Baggs in a new corridor to Coyote Springs, where it would follow another Amoco small-diameter crude pipeline to Fort Laramie.

7.17.1.1 Technical Considerations

The approximate distances in miles for the two alternatives are shown below:

	Existing Corridors	New Corridors	Total
Alternative 1	200	80	280
Alternative 2	237	85	322

Alternative 1 would require the construction of the shortest pipeline. However, since Alternative 2 would intersect the main crude carriers farther east, the overall transportation distances to the Midwest would be shorter. In the case of Alternative 1, the installation of additional pumping capacity would be required from Casper to Fort Laramie. From Fort Laramie eastward, any changes needed in pumping capacity would be the same for both alternatives.

Both alternatives would require securing a new right-of-way along part of the proposed corridor.

7.17.1.2 Environmental Considerations

No field reconnaissance of these alternative pipeline routes has been made, and topographical maps were used in judging terrain conditions. All of the routes would appear to traverse approximately the same type of terrain. No meaningful environmental tradeoffs were immediately evident between Alternatives 1 and 2.

7.17.2 ALTERNATIVE MARKET DISCUSSIONS

Other markets for the shale oil, which would require alternative pipeline routes, were also discussed but never seriously considered, for the reasons given below.

7.17.2.1 Los Angeles Basin Market

To serve this market, a pipeline could be constructed south from the project site to the Four Corners area of Utah where connections could be made with pipelines serving the Los Angeles Basin. Shale oil from the WRSP would have to compete with North Slope crude from Alaska, which is currently destined for markets on the Pacific Coast, including the Los Angeles Basin.

7.17.2.2 Salt Lake Basin Market

This market would require the construction of a new pipeline from the project site to the Salt Lake Valley. There is an existing pipeline corridor between Rangely and Salt Lake City with small-diameter crude lines. The major problem is that the demand for crude oil and refining capacity in the Salt Lake Basin is limited, and the total output of the project probably could not be absorbed there.

Section 7.18

Section 7.18

BY-PRODUCT PLAN

In this section, the by-products of alternative upgrading systems (described more fully in Section 7.8) are considered. The by-products are as follows:

- Coke
- Ammonia
- Claus sulfur
- Heavy unrefined oil
- Propane-propylene liquefied petroleum gas (C_3 -$C_3^=$ LPG)
- Surplus gas and/or power

The type and amount of by-products depend on the upgrading procedure employed, as shown in Table 7.18-1.

7.18.1 COKE

Coke is a by-product in only two of the eight upgrading alternatives given in Table 7.18-1. It can be burned in a utility plant to produce power. The coke may be marketable as a metallurgical coke or an electrode coke, or it can be burned directly in a boiler.

7.18.2 AMMONIA

Ammonia is a by-product in four of the eight upgrading alternatives. The ammonia produced may be sold as anhydrous liquid ammonia, which can be used as fertilizer. Ammonia requires storage facilities, a loading rack, and truck transport facilities.

7.18.3 SULFUR

The sulfur is produced as a marketable by-product.

7.18.4 SURPLUS GAS OR POWER

Surplus gas or surplus electric power is produced in all eight alternatives. The surplus gas can be burned as a fuel on the tract; it can be converted to electric power in a utility plant on the tract; it can be sold to an adjacent utility plant; or it can be incinerated or vented on the tract. The amount of surplus gas and electric power produced for each alternative depends on the option employed. For more details see Section 7.8.

7.18.5 HEAVY UNREFINED OIL

Heavy unrefined oil is a by-product of heavy oil cracking processes. This oil could probably be burned in a utility plant; it can be sold as a specialty product; or it can be sold to refineries in the area.

7.18.6 LIQUEFIED PETROLEUM GAS (LPG)

The by-product C_3-$C_3^=$ LPG is an olefinic gas that meets the LPG specification for sulfur content and dryness. It may be sold as a specialty product because it contains propylene, possibly useful as a chemical raw material. Like ammonia, this LPG requires storage facilities, a loading rack, and truck transport facilities.

Table 7.18-1

BY-PRODUCTS OF UPGRADING ALTERNATIVES

Alternative	Upgrading Scheme [a]		Sulfur, TPCD	Ammonia, TPCD	Coke, TPCD	Unrefined Heavy Oil, BPCD	LPG, BPCD	Surplus [a] Gas or Power (Relative Quantity)
1	None	Crude shale oil	29	0	0	0	0	High
2	Mild	Visbreaking	33	0	0	0	0	High
3		Delayed coking	36	0	2,420	0	1,550	High
4		Heavy oil cracking hydrostabilization	52	0	0	1,000	4,680	High
5	Moderate	Hydrotreating	163	370	0	0	0	Low
6	Severe	Delayed coking hydrotreating	136	290	2,260	0	0	Moderate
7		Severe hydrotreating	165	412	0	0	0	Low
8		Heavy oil cracking hydrotreating	129	274	0	1,000	0	High

(a) See Section 7.8, "Shale Oil Upgrading," for details.

Section 7.19

Section 7.19

CONSTRUCTION PLAN

This section addresses the alternative selection of a construction campsite to cover the construction involved in the last three phases of the project: Phase 2, single retort operation; Phase 3, commercial operation, first-train; and Phase 4, commercial operation, two-train. It includes a discussion of the pertinent aspects of the alternative location, its access, and the selection rationale employed. The construction plan selected as part of the probable development plan is described in Section 3.19.

7.19.1 ALTERNATIVE SCHEDULES

The plans and schedules for construction of the single retort phase and the staged building of the first and second trains of the plant are the same as cited in Section 3.19 and presented in Figure 3.19-1. No changes that would affect the schedules associated with the most probable plan of action described in Part 3 of this Detailed Design Plan have been contemplated.

7.19.2 ALTERNATIVE CAMPSITE

The alternative campsite to the one selected for the most probable plan is an on-tract site located on the east-central extreme of Tract U-b. It comprises approximately 160 acres (1/4 of a section) of land at the location shown in Figure 7.19-1. The terrain involved is at an altitude of approximately 5,500 feet, and portions are hilly. The size of this plot is sufficient to provide for construction campsite needs during the last three phases of the project, through full-scale commercial operation. This can be managed through a properly planned expansion plan for the camp and its facilities so as to accommodate the maximum work

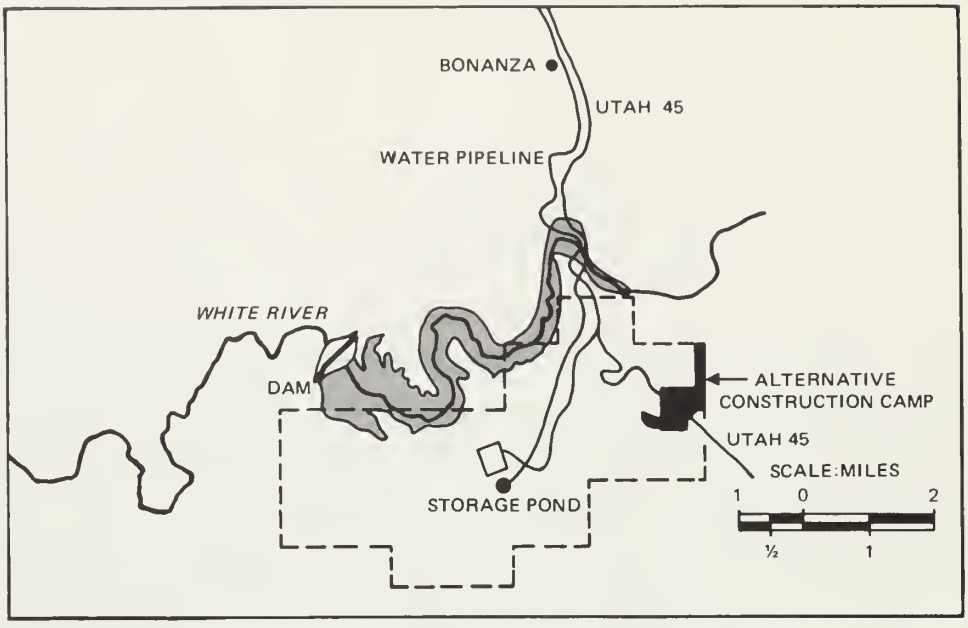

Figure 7.19-1. Alternative Campsite in Bonanza

force as it increases to the expected peak level of 3,935. The camp would include provision for both bachelor and family quarters and units. The capacity and description of facilities within the camp, at this stage of planning, should not differ materially from that described in Section 3.19.

7.19.3 ACCESS

Access to the area is by Utah Route 45 (See Figure 7.19-1), which extends south from Bonanza across the White River and across the other active tributary of the White River system, a watershed known as Evacuation Creek. State Highway 45 should be paved and improved by the time of any potential use of the alternative campsite on Tract U-b. Discussions have been held with the Utah Department of Transportation, the Bureau of Land Management, and with the Uintah County Comissioner regarding alternative routes for an access road from Bonanza to the proposed plant site.

7.19.4 ALTERNATIVE EVALUATION

The federal lease terms of both U-a and U-b provide for use of the land for construction campsites — subject, of course, to the normal approval procedures set forth in the document covering land-use permits. With regard to accessibility of utilities, the location on Tract U-b is about equivalent to the off-tract preferred location described in Section 3.19. Access to the property is judged to be also nearly equivalent, except that the U-b location is closer to the construction area. Impact on the environment is also expected to be about the same regardless of location, since the same number of people would be involved.

7.19.5 SELECTION RATIONALE

The rationale for preferring the off-tract location to the U-b site is as follows:

- Environmental, utility, sanitary, and other factors associated with a construction campsite are about similar.
- Access from the campsite to larger community facilities, such as shopping and entertainment favors the off-tract location.
- The terrain is more level on the off-tract site than the U-b site. In an equivalent area, the off-tract site contains more usable ground for the camp, its facilities, and recreation needs.

GLOSSARY

Abandonment. A relinquishment or a termination of the lease and no sale to another party of the permanent improvements.

Acid gas. The hydrogen sulfide and carbon dioxide found in natural and refinery gases which, when combined with moisutre, form corrosive acids; these are known as sour acids when hydrogen sulfide or mercaptans are present.

Acre-foot. The volume of water that can cover one acre to the depth of one foot (325,850 gallons). One acre-foot per year equals 0.62 gallon per minute.

Alluvium. Clay, silt, sand, gravel, or similar detrital material deposited by running water.

Amine. One of a class of organic compounds which can be considered to be derived from ammonia by replacement of one or more hydrogen atoms by organic radicals.

Amine gas-treating unit. A unit that absorbs and removes acid gas from product gas by contacting the product gas with an aqueous solution of amine.

AOSO. Area Oil Shale Office.

AOSS. Area Oil Shale Supervisor.

Aquifer. A water-bearing stratum of permeable rock, sand, or gravel.

AUM. Animal unit month. The amount of forage on an acre of land required to support one cow or five sheep for one month.

Baseline environmental data. Data on Tracts U-a and U-b developed WRSP. This information is summarized in Part 2 and in the First Year Annual Baseline Report prepared VTN (see "baseline environmental data").

Bbl. Barrels.

Berm. A narrow shelf, path, or ledge typically at the top or bottom of a slope.

Biota. The collective flora and fauna of any particular area.

BPCD. Barrels per calendar day (one barrel = 42 gallons; a calendar day includes downtime).

BPSD. Barrels per stream day.

Bottoms. Oil, water, and foreign matter that collect in the bottom of storage tanks.

Btu. British thermal unit, a unit of energy.

C_5+ refined shale oil. Pentane and heavier shale oil.

Catalytic converter. A cracker that uses catalysts.

Catalytic cracking. Conversion of high-boiling-point (high molecular weight) hydrocarbons into lower-boiling-point (lower molecular weight) types by heating the hydrocarbons in the presence of a catalyst.

Catchment. (See "single retort phase dam.")

Centroid. (See "oil shale deposit centroid.")

Claus sulfur plant. A plant that converts hydrogen sulfide in a gas stream into elemental sulfur by means of solid catalysts.

Coke. A coherent, cellular, solid residue remaining from the dry (destructive) distillation of a coking coal, petroleum, or other carbonaceous material.

Coking. Destructive distillation of coal to make coke; a process for thermally converting the heavy residual bottoms of crude oil entirely to lower-boiling-point petroleum products and by-product petroleum coke (thermal cracking for the conversion of heavy, low-grade oils into lighter products and a residue of coke).

Commercial Operation Phases. (See "Phase III" and Phase IV.")

Cracking. Conversion of high-boiling-point (high molecular weight) hydrocarbons into lower-boiling-point (lower molecular weight) hydrocarbons.

Crude shale oil. The oil produced by heating oil shale in a retort.

CS. Centistokes, a unit of viscosity.

Cut-and-fill. A process for leveling land (to build roads, etc.) in which higher elevation land is removed and placed in lower elevation land to create a flat surface.

dB. Decibel.

dBA. Decibel (acoustic).

Decibel. A unit for measuring the relative loudness of sounds and approximately equal to the smallest degree of different of loudness ordinarily detectable by the human ear. The range includes about 130 decibels on a scale beginning with 1 for the faintest audible sound.

Decommissioning. The suspension by the lessee of the work programs or the further processing of shale, without dismantling or destroying improvements.

DDP. Detailed Development Plan.

DH. Direct heated.

Direct heated mode. A method of imparting heat to the shale, whereby fuel and oxygen are injected into the retort for combustion and direct contact heat transfer.

Drainage basin. The entire tract of country drained by a river and its tributaries.

Feed. Raw material that is fed into and processed in a unit.

Feed gas. Gas that is fed into and processed in a unit.

Fines. Smaller particles of oil shale coming out of the mine, or from the crushing operation. Fines are generally pea-sized and smaller (1/2-inch and under) and must be removed from the feed of certain retort systems.

Fischer assay. A standard laboratory method for determining the amount of oil in shale. The results are expressed as gallons of oil per ton of oil shale.

First-train operation. Commercial operation during Phase III.

Flue gas. The waste product of the combustion of fuel in the heater of an IH retorting system.

Forb. An herb other than grass.

Fugitive dust. Colloidal-sized particulate matter generated incidentally by man's activities.

Gas treating. Removing nonhydrocarbon impurities (such as water vapor, hydrogen sulfide, or carbon dioxide) from product gas.

Gilsonite. A black lustrous asphalt occurring especially in Utah (trademark).

GPT. Gallons per ton.

gr/SCF. Grains per standard cubic foot.

HHV. High heating value.

High-Btu gas. A high heating value gas. The product gas from IH retorting is a high-Btu gas.

Holding basin. (See "wastewater and storm runoff holding basin.")

HTU. Hydrotreating unit.

Hundred-year flood. The maximum flood that can be expected in a 100-year period.

Hydrocarbon. An organic compound containing only carbon and hydrogen.

Hydrotreating. An oil refinery catalytic process in which hydrogen is contacted with petroleum intermediates or product streams to remove impurities, such as oxygen, sulfur, nitrogen, or unsaturated hydrocarbons.

Hydrostabilization. A mild hydrotreating process that uses less hydrogen than hydrotreating.

IH. Indirect heated.

Indirect heated mode. A method of imparting heat to the shale by an externally heated circulating gas stream.

In situ. Derived from the Latin term meaning "in place." With reference to oil shale, it describes a method of underground retorting whereby the oil is recovered and the shale residue is left in the ground.

Kerogen. The organic portion of oil shale. It is a hydrocarbon that breaks down when heated (to about 900° F) to form a synthetic oil.

kV. Kilovolts (1,000 volts).

kW. Kilowatts (1,000 watts).

Leachate. A solution or product obtained by leaching.

Light ends. The lower-boiling-point components of a mixture of hydrocarbons, such as those evaporated or distilled off easily in comparison with the bulk of the mixture; for hydrocarbon mixtures, this is usually considered to be butane or lighter.

Low-Btu gas. A gas with a low heating value. The product gas from DH retorting is a low-Btu gas.

Marlstone. A rock consisting of approximately equal amounts of carbonate and clay. Oil shale is basically a marlstone.

Mining panel. In the room and pillar method, a large area in the mine in which many pillars are left to support the roof.

MMM. Billion.

MW. Megawatts (one million watts).

Nahcolite. The mineral sodium bicarbonate. It is potentially commercially valuable for removing sulfur from flue gases.

Naphtha. (See "petroleum naphtha.")

Oil Shale. Laminated sedimentary rock deposits containing both mineral and organic matter, principally kerogen.

Oil shale deposit centroid. The center of mass of the oil shale, as determined by geological studies.

Oolitic. The quality of having small round bodies that have grown by external accumulation. Usually refers to a sedimentary rock.

OSEAP. Oil Shale Environmental Advisory Panel.

Overburden. Nonresource-bearing strata overlying the oil shale.

Panel. (See "mining panel.")

Paraho. A retorting method, either DH or IH, in which minus 3-inch plus 1/2-inch shale is processed in a vertical kiln retort.

Particulates. Solid materials generated by processes and emitted from a discrete source (see "fugitive dust").

Petroleum naphtha. A generic term applied to refined, partly refined, or unrefined petroleum products and liquid products of natural gas.

Phase I. The initial mine access phase.

Phase II. The phase during which a single commercial sized retort, along with working mine and ancillary facilities, is developed.

Phase III. The first of two commercial operation phases, culminating in single-train operation.

Phase IV. The second of two commercial operation phases, culminating in full-scale two-train operation.

Portal. The surface entrance to a drift, tunnel, adit, or entry.

Pour point. The lowest temperature (determined by laboratory procedure) at which a liquid hydrocarbon will remain fluid enough to be poured.

Pour point depressant. An additive that lowers the pour point of a wax-containing petroleum-base lubricating oil by reducing the tendency of a wax to solidify.

Processed shale. The residue shale from the retorting operation. It is normally 80 to 85 percent the weight of the original oil shale material.

Product gas. The gas emitted from the DH or IH retort during the retorting of shale oil.

Pyrolysis. Chemical change brought about by the action of heat.

Reforming. The thermal or catalytic conversion of petroleum naphtha into more volatile products of higher octane number; represents the total effect of numerous simultaneous reactions, such as cracking, polymerization, dehydration, and isomerization.

Reforming catalyst. A catalyst used in a reformer.

Retort. A vessel through which the oil shale passes and the retorting process is carried out.

Retorting. The process in which the kerogen in oil shale is converted by heating to an oil.

Room and pillar. An underground mining technique in which a room is mined out and a pillar is left for mine support.

Room. The opening in a mine between pillars.

SCFCD. Standard cubic feet per calendar day (SCF measured at 60°F and 1 atmosphere).

SCFM. Standard cubic feet per minute.

SCFSD. Standard cubic feet per stream day (stream day does not include downtime).

Scrubber. (See "wet scrubber.")

Shale Oil. A black, tarry liquid product produced from the retorting operation.

Single retort operation. (See "Phase II.")

Single retort phase dam (catchment). A dam built during Phase II adjacent to the processed shale pile, the purpose of which is to intercept runoff and leachate from the single retort processed shale pile.

Slurry. A watery mixture of insoluble matter.

Sour gas. A gas mixture that contains hydrogen sulfide or mercaptans.

Sour water. Water containing hydrogen sulfide or mercaptans.

Sour water stripping. Removing hydrogen sulfide from sour water.

Southam Canyon retention dam. A dam built during Phase III at the mouth of Southam Canyon, the purpose of which is to intercept processed shale runoff and leachate and hence prevent them from reaching the White River.

Stope. An underground excavation from which the ore has been extracted, in a series of steps.

Storage silo. A circular vessel, usually having a conical bottom section, that is used for storing solids in bulk quantities.

Stretford sulfur unit. A plant that converts hydrogen sulfide in a gas stream into elemental sulfur by using a catalyst in a liquid medium.

Surge bin. A storage vessel that holds a sufficient volume of material to provide a steady supply to a downstream user or process.

Tail gas. Waste gas from a sulfur-treating plant.

Tail gas treating. Removing sulfur from tail gas.

Tank farm. An area containing large storage tanks for oil or other liquids.

TBP. True boiling point.

TDS. Total dissolved solids.

TOSCO. A retorting method, in which minus 1/2-shale is processed in an IH retort.

TPCD. Tons per calendar day.

TPD. Tons per day.

Train. A processing system comprising a series of processing units.

Transect. A sample area (as of vegetation), usually in the form of a long continuous strip.

Tuff. A rock composed of the finer kinds of volcanic detritus, usually fused together by heat.

Turndown ratio. A measure of a unit's ability to operate at lower rates.

Two trains. Two parallel processing systems.

Upgrading. The various process combinations employed to improve the quality of the oil.

Vector. Any organism that is the carrier of a disease-producing virus or bacteria.

Visbreaking. A mild thermal cracking process that lowers the molecular weights of the hydrocarbon molecules only slightly.

VTN. A Denver-based company that specializes in engineering and environmental studies.

Water bar. A ridge built across a road to divert runoff.

Wet scrubber. A vessel in which spray liquid is used to absorb solid particles and remove them from circulating gases.

WEA. Western Environmental Associates.

WRSP. White River Shale Project.

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